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Volume I

V. L. Komarov, Editor

Archegoniatae and Embryophyta

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Volume I

Archegoniatae and Embryophyta

Chief Editor Academician V. L. Komarov

Volume Editor M. M. Il'in

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SUBJECTS AND CONTRIBUTORS

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Regions of the Flora of the U. S. S. R. Regions accepted for the distribution of species included in the Flora of the U. S. S. R. Maps. General abbreviations. Systematic index of species in Volume I.	Editorial Staff
Class: Filicales	Arranged by A. V. Fomin
" Equisetales	" " M. M. Il'in
" Lycopodiales	" " M. M. Il'in
" Isoetales	" " M. M. Il'in
" Coniferales	" " V. L. Komarov
" Gnetales	" " E. G. Bobrov
Subdivision Angiospermae	
Family: Typhaceae	Arranged by B. A. Fedchenko
" Sparganiaceae	" " S. V. Yuzepchuk
" Potamogetenaceae	" " S. V. Yuzepchuk
" Zosteraceae	" " S. V. Yuzepchuk
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" Butomaceae	" " B. A. Fedchenko
" Hydrocharitaceae	" " B. A. Fedchenko
Characteristics of the orders, suborders, classes and genera; plates for determination of orders and families	Arranged by V. L. Komarov
Paleobotanic information	" " A. N. Krishtofovich
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SYSTEMATIC INDEX OF SPECIES
in Vol. I of the "Flora of the USSR."*

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Subdivision **Pteridophyta**

Class I. **FILICALES**

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PREFACE

I

Our economic organizations are carrying out at present a survey of the plants of the Soviet Union that provide important raw materials. Among the plants investigated are those yielding rubber, tanning agents, essential oils, drugs, etc. All this calls for a sound knowledge of wild plants, discrimination between them, ability to distinguish between useful and useless ones, and knowledge of habitats and locations. In the case of numerous plants that are being introduced into cultivation, it is necessary to lay in supplies of seed or rootstocks and to determine growth conditions.

Weed control in agricultural practice again necessitates a thorough knowledge of noxious plants, their origin and requirements. Parasites of crop plants often derive from wild plants; and again it is necessary to know the plants involved and their whereabouts. In short, we are continually faced with the need for determining the composition of the plant world that surrounds us. Far from being fully exploited, the available plant resources are often not even fully appreciated.

The only scientifically elaborated method for securing a plant inventory is the compilation of floras. A flora, i. e., the aggregate of all plants of a given region, a given country, or the entire world, can be definitely ascertained only by way of description of each of the known species comprising that particular flora.

The word **flora** is of Latin origin and designates plants as a whole. The expression "rich or poor flora" does not signify a large or small bulk of plants, but refers solely to their diversity. A rich flora contains a large number of species; a poor flora is composed of few species. The term was first employed in this sense as far back as 1656 (Boym, *Flora sinensis*, Vienna), and then again by Linnaeus in 1737, with the publication of his short *Flora Lapponica*.

Of particular importance for the Soviet Union is the Russian Flora published by Ledebour "*Flora Rossica sive enumeratio plantarum in totius imperii Rossici provinciis europaeis, asiaticis et americanis hucusque observatarum*," auctore dr. C. F. a Ledebour, Stuttgartiae, Vol. I, 1842, Vol. II, 1844—46, Vol. III, 1846—51, Vol. IV, 1853. It contained descriptions of 146 families, 1139 genera, and 6568 species, not counting varieties. This work, which was achieved with the cooperation of other German botanists, such as Fenzl, E. Mayer, and Griesebach, is written in Latin and contains descriptions and geographical distribution of all plants on Russian territory known at that time. However, the territory itself changed subsequently and the number of known plants increased in the course of time, so that already in 1883 Trautvetter published a supplementary catalog to Ledebour's Flora, under the title *Incrementa Florae Phaenogamae Rossicae congregavit E. R. a Trautvetter* which contained 6106 species

(printed in Trudy Peterburgskogo Botanicheskogo Sada [Proceedings of the Petersburg Botanical Garden], Vol. VIII, 1883, and Vol. IX, 1884).

No later attempts were made to describe, or even to list, the plants of Russia as a whole, and local floras came into the picture. The works considered to be most important in this category for the European part of the USSR, including: the RSFSR*, the Ukraine, Belorussia and the Crimea, are: (1) I. F. Schmalhausen, *Flora Srednei i yuzhnoi Rossii, Kryma i severnogo Kavkaza* (Flora of Central and Southern Russia, the Crimea and Northern Caucasus), Kiev, Vol. I, 1895, Vol. II, 1897, containing 118 families, 797 genera, and 2714 species; (2) B. A. Fedchenko and A. F. Flerov, *Flora Evropeiskoi Rossii, illyustrirovannyi opredelitel' dikorastushchikh rastenii Evropeiskoi Rossii i Kryma* (Flora of European Russia, an Illustrated Key to Wild Plants of European Russia and the Crimea), 1910, with 1084 illustrations, describing 124 families, 831 genera, and 3541 species (showing an increase of 30% in the number of species within 15 years).

Up to the present there is no complete flora of the Caucasus. There is a very large number of specialized studies, such as those by Ruprecht, Lipsky, N. I. Kuznetsov, N. A. Busch, Maiorov, D. I. Sosnovkii, A. V. Fomin, and others. Kuznetsov's grandiose work (*Flora Caucasica critica*, 1901—1916) remained unfinished, and a full list of Caucasian plants had to be looked for elsewhere. We may mention in this connection: (1) V. I. Lipsky, *Flora Kavkaza* (Flora of the Caucasus), 1899, containing 125 families, 882 genera, and 4430 species; (2) A. A. Grossheim, *Flora Kavkaza* (Flora of the Caucasus), Vol. I, 1928, Vol. II, 1930, Vol. III, 1932, Tiflis [Tbilisi]; an additional volume is still expected. The already published part of Grossheim's work presents 122 families, 859 genera, and 4364 species. On the assumption that Volume IV will offer as much as Volume III, the total will amount to 134 families, 1200 genera, and 5820 species. This does not account for all the riches of the Caucasian flora, and Yu. N. Voronov estimates this flora, when fully worked out, at 9000 species.

For Turkestan we have a comprehensive catalog: B. A. Fedchenko, *Rastitel'nost' Turkestana, illyustrirovannoe posobie dlya opredeleniya rastenii, rastushchikh v Turkestanskom krae i Kirgizskikh stepyakh* (The Vegetation of Turkestan, an Illustrated Aid to Identification of Plants Growing in the Turkestan Region and Kirghiz Steppes), Petrograd, 1915; the work contains 114 families, 826 genera, and 5031 species.

A complete work dealing with Western Siberia and partly the Urals is that of P. N. Krylov, *Flora Altaya i Tomskoi gubernii, rukovodstvo k opredeleniyu rastenii Zapadnoi Sibiri* (Flora of Altai and the Tomsk Province, a Guide to Identification of Plants of Western Siberia), Tomsk, 1, 1901—VII, 1914, which contains 108 families, 543 genera, and 1787 species. The other work by P. N. Krylov is *Flora Zapadnoi Sibiri* (Flora of Western Siberia), Tomsk, part 1, 1927—part 6, 1931. So far slightly more than half of the work has appeared, from Pteridophyta to Saxifragacea inclusive. This part comprises 52 families, 330 genera, and 1296 species. Doubling these figures will yield 104 families, 660 genera, and 2592 species.

A classical work dealing with Eastern Siberia is by N. S. Turchaninov, *Flora Baicalensi-Dahurica*, Pars I, 1842—45, Pars II, 1856, Moscow, which covers 95 families, 464 genera, and 1402 species.

A work being published at present in instalments is *Flora Zabaikal'ya* (Flora of Transbaikalia) under the editorship of B. A. Fedchenko. The

* [The Russian Soviet Federated Socialist Republic.]

issues that have appeared so far are No. 1, 1929, and No. 2, 1931. These contain pteridophytes, gymnosperms and monocotyledons; 22 families, 128 genera, and 494 species in all, which corresponds to the 20 families, 112 genera, and 332 species by Turchaninov, i. e., an increase of nearly 50% over the number of Turchaninov's species.

A summary of earlier classical studies of the Far Eastern flora by K. I. Maximowicz, F. B. Schmidt, R. K. Maack, and others, is provided by the following publications: V. L. Komarov, *Flora poluostrova Kamchatki* (*Flora of the Kamchatka Peninsula*), I—III, 1927 and 1930, with 70 families, 302 genera, and 828 species; E. Hulten, *Flora of Kamchatka and the Adjacent Islands*, I—IV, Stockholm, 1927—30, with 782 species; and V. L. Komarov and E. N. Alisova, *Opredelitel' rastenii Dal'nevostochnogo kraia* (*A Key to Plants of the Far Eastern Territory*), I—II, 1931—1932, with 330 plates presenting 124 families, 773 genera, and 1966 species.

Concerning regions, in which the plants have not yet been catalogued, there are also specialized studies that give an indication of the extent of the floras concerned. But by far the most important source for a comprehensive investigation of the USSR flora is the Herbarium of the Botanical Institute of the Academy of Sciences (known by the initials BIN) which comprises the collections of most Soviet botanists as well as those of their forerunners, beginning with Pallas (died in 1811). Turchaninov and Ledebour. It is true that herbaria left by some botanists found their way abroad after their death, as for instance the herbarium of Prof. Bunge, while many valuable finds relating to the Caucasus and Turkestan are deposited in the herbaria of Tiflis and Tashkent; all the same, the resulting gaps are rather insignificant.

The whole of the enormous BIN Herbarium counts not less than 15,000 species growing within the USSR boundaries, although some computations place the figure at 20,000. The task of describing such a large number of species is clearly beyond the powers of one man. That is the reason why Ledebour's *Flora Rossica* has remained for so long the only flora for "one-sixth of the land surface of the earth" without any sequel.

The staff of the BIN Herbarium proved to be more resourceful and not merely took upon itself the composition of the "Flora of the USSR" but undertook to accomplish the task in the relatively short period of five years, which involved an extraordinary strain. It was necessary to call upon the cooperation of botanists from Moscow, Kiev, Tashkent, Baku, etc., so as to turn this into an All-Union achievement. The complete Flora will comprise about 15 volumes, scheduled to appear at the rate of 1 to 3 per year, depending on the available means. It is clear that, even if the manuscript is fully ready by the appointed date, the printing will take more time than composition.

The material will be organized in accordance with the system proposed by Engler (*A. Engler, Syllabus der Pflanzenfamilien, eine Übersicht über das gesamte Pflanzensystem*, 9 und 10 Auflage mit Unterstützung von dr. E. Gilg., Berlin, 1924). Although it has lately been criticized, it remains all the same the only fully elaborated and fully completed plant system. The condition imposed upon all collaborators was to devote as much attention as possible to plant habitat and to the value or harmfulness to man.

It is clear that plant descriptions will of necessity have to be shorter than might be desired by the editors and readers alike, as the provision of complete descriptions for many thousands of species would result in unmanageable bulk.

In issuing this first volume, the editors express the hope that readers will communicate any shortcomings they may experience in perusing it and will thus contribute valuable methodological suggestions for improving subsequent volumes.

Insofar as the "Flora of the USSR" serves as a key to plant identification, a word of caution is called for. J. B. Lamarck, who had invented the dichotomous keys for plant identification, challenged his friends to a bet that the first literate person who might happen to pass by and be willing to sacrifice half an hour, even though he had never before occupied himself with botany, would be able to track down correctly a plant handed to him with the aid of the keys newly prepared by the scientist for his "Flore de France." Lamarck's biographers affirm that the experiment was indeed quite successful.

Our own experience shows, however, that plant determination is not easy even with the best of keys. After tracking a plant down by the book, we usually check it against earlier identified plants preserved in the herbarium. We therefore do not doubt that plant identification solely by our book will often lead to errors. All the same, one cannot manage without a book. We approach our readers with the request that in all difficult cases they consult a textbook of plant morphology and systematics and thoroughly clarify the morphological terms.

Our chief aim — the establishment of a complete inventory of plant raw materials — is somewhat easier to achieve. But it is desirable that readers transmit to the editors of the "Flora" their queries relating to exploitation, usefulness or harmful properties, since much knowledge concerning various applications of plants, current among the population of certain localities, has not yet found its way into the literature and is unavailable to botanists.

In our times, only general cooperation provides a guarantee of success in all great scientific undertakings.

II

The center of gravity of this, as of any other flora, consists in the descriptions of plant species. "Species" is the fundamental unity with which we are concerned. Every botanist incessantly handles species throughout his life, even though, when actually faced with the question "What is a species?", he is hard put to provide an explanation or refrains from answering altogether. This is due to the fact that, in nature itself, the fluidity of morphological and genetical properties of plant organisms renders the manifestation of "species" extremely hard to define. Interactions between an organism and its environment as well as interactions between generative and vegetative modes of reproduction render the organisms highly flexible. It was easy to provide short specific definitions as long as species was considered to be constant. However, with the emergence and consolidation of evolutionary science and the progressive discovery of the dialectics of related processes in nature, it has become exceedingly difficult to tie down the ever changing substance of "species" to a fixed formula. The task is rendered even more difficult by the fact that manifestation of "species" is not the same in different plant groups.

Some species are distinguished by great consistency and marked distinction from related species. Plants such as yellow flat, *Iris pseudoacorus* L., Norway apple, *Acer platanoides* L., and *Rhododendron chrysanthum* Pall., never raise any doubts as regards the purity of their specific distinctiveness. For such species there are no reports of varieties, hybrids, or synonyms, that would tend to confuse the clear conception as to their standing. In spite of their wide distribution, these species have become so adjusted to specific habitats, that the environment tends everywhere to exert on them a preserving rather than a modifying influence; the formative apparatus of these plants remains undisturbed under any environmental effects. Such species lend themselves very readily to treatment and description. Another example, of a somewhat less stable organism, is provided by *Chamaenerium angustifolium* Scop., that grows practically all over the USSR and is nearly everywhere invariable and striking in its persistence; however, in the mountains of Kamchatka, and possibly in other analogical habitats, it already gives rise to deviating forms wherever it comes into contact with the only related species, *Chamaenerium latifolium* Scop. The occurrence of these can be readily explained by assuming that the two species hybridize, and such hybridization does in fact take place. All the same, it is not easy to determine the intermediate forms, as the specific characters are confused.

Diagnosis presents even greater difficulties in those instances where a plant, which at one time covered an extensive area, has given rise to modifications due to interaction with environment. Thus *Betula nana* L. in Europe has puberulent branches, while in Eastern Siberia the young branches are densely verrucose-glandular. For this reason, V.N. Sukachev separated the East Siberian dwarf birch from the European under the name *B. exilis* Suk. On the other hand, even though the young branches of the European *Padus racemosa* C. K. Schneider are quite glabrous, whereas those of the East Siberian bird-cherry are pubescent, the latter form has not so far been recognized as a distinct species but merely as var. *pubescens* Rgl.

Where the process of geographic isolation is more advanced, we have whole series of related species which represent various stages of establishment and differentiation of the common ancestor. As many features of this progenitor are shared by all species of such a series, earlier authors mostly recognized only one species or else did not pay any attention to the characteristics associated with representatives from different geographic regions; in other instances they recognized them as varieties or at most as subspecies. Such subspecies are very important both biologically and economically, in that they differ markedly in the products which they yield, in resistance to climatic extremes, etc. The authors of the "Flora of the USSR" therefore endeavor to distinguish such species, many of which have not so far been described.

In many cases the variability of related forms is not geographically organized and has different causation. Such forms have come into being as a result of hybridization and subsequent environmental selection. Where such plants as willows, violets, brambles or adenophores lose the features that normally distinguish their species, they give rise to numerous forms that do not lend themselves easily to classification and description. Such cases should be considered as hybrid cycles where the conception of species

for morphologically defined individuals is not applicable. Hybrids are usually designated by a cross sign between the names of two or more species which participated in the hybridization concerned. In cases where a given hybrid population is sufficiently large and its characters are fixed, it may acquire a specieslike appellation.

It is known that, while enhancing growth, hybridization adversely affects pollen development and often impedes the fertilization process. In certain overhybridized groups seeds may actually develop without fertilization. Apogamic generations arise in which the characters of the initial individuals are thus outstandingly preserved. The numerous individuals of such generations seem to be parts of the original individual. Now, as in the case of hybridization following Mendelian laws, the characters of parent species form various often highly characteristic combinations, and the descendants of the original mendelizing individual are carriers of distinct combinations of fixed hereditary characters. Consequently, in genera such as *Alchemilla*, *Taraxacum*, *Hieracium*, and some others, a large number of apogamous "species" has arisen, and these render the process of plant determination exceedingly difficult. Thus, side by side with clearly defined species which retain their distinctiveness wherever they happen to grow, there are numerous plants which display a definite geographic variability and significant groups of plants involved in hybridization processes, Mendelian variability, and apogamy. It is clear that all these manifestations are not equivalent, but they are of equal importance insofar as differences in characters and properties of economic importance depend not only on phylogenetic affiliation but also on racial distinctiveness.

There are two opposite approaches of long standing in species systematics. The one, associated with the names of the English botanists Bentham and Hooker and the Russian K. I. Maximowicz, laid stress chiefly on elucidation of kinship between different organisms. With this in view, newly described forms were referred as far as possible to already known species and integrated into a system of subspecies and varieties. Thus, Maximowicz, in analyzing the features of Asian spindle-trees, arrived at the conclusion that the European *Euonymus europaea* L., the Himalayan *E. Hamiltoniana* Wall., the Japanese *E. Sieboldiana* Blume, and the Far Eastern *E. Maackii* Rupr. differ from each other merely in secondary characters and that they should all be regarded as a single species, with the Asian forms forming the subspecies *E. Hamiltoniana* Max. differing from the European species chiefly in the blackish-purple anthers as opposed to the rusty-yellow anthers of the European forms. In this way Maximowicz established close phylogenetic ties between the four spindle-trees, underlining the fact that they are more closely related to one another than to any other spindle-tree.

These studies of Maximowicz make it possible to make deductions concerning the place of origin of this group of spindle-trees, their subsequent spread, and the effect of climate in various parts of their distribution area on the selection processes involved in the formation of their characteristic features. All this does not, however, provide grounds for any a priori conclusion as regards the presence or amount of gutta-percha in the leaves. This can only be determined by studying each of the forms involved separately.

The opposite approach is to regard as distinct species any plants, however closely related, provided they display a hereditarily transmitted

distinguishing character. Thus, in plant determination as such, the indication of relationship to other plants is disregarded. If we still desire to retain the evolutionary point of view, we have to ensure the association of our species by combining them into aggregate species, species cycles, and series. The genus or subgenus is first broken up into series, and each series is then again subdivided into species. The series takes in a way the place of the Linnaean species, breaking up in the process of evolution into real geographically localized contemporary species.

The collaborators of the "Flora of the USSR" adopted the second approach as better suited to economic requirements in connection with agricultural introduction of wild plants. With this approach, the ascertainment of the current evolutionary process also renders the recognition of minor species and series of species more acceptable from the point of view of dialectical interpretation of nature.

III

The problem of genera resembles to some extent the problem of species. The contemporary tendency of systematics is to split large composite genera into smaller ones. There is, however, a notable difference. Only in exceptional cases does generic classification reflect the current evolutionary process. As a rule, it relates to a more distant past and provides in a way a memorial of an evolutionary process already largely accomplished. This being so, considerations of taxonomic expediency come to the fore. It is not easy to memorize the very large number of generic appellations. Wherever the professional botanist can use the names with which he is familiar, these ought to be retained. Generic names with mnemotechnical associations represent the most important part, the very basis, of botanical nomenclature. Very many generic concepts are already firmly established in the agricultural vernacular and from there find their way into our floras. The names of trees, such as pine, spruce, fir, birch, lime, maple, ash, etc., are in full agreement with botanical generic concepts; names of cultivated plants, such as rye, wheat, oats, pea, also conform to the botanical names of the genera; similar agreement applies to some wild herbaceous plants, e. g., brome-grass, sedge, nettle, wheatgrass, bellflower, or wormwood. All such genera clearly provide a basis for memorization of plant names and, as a basis, they should be constant in all languages.

The problem of genera comes close to the problem of Russian plant names. The authors of the "Flora of the USSR" provide Russian nomenclature systematically throughout the flora. This nomenclature is based on the firmly established Russian plant names to which we have just referred. Similarly indisputable are the numerous widely current plant names of foreign origin, such as fialka [violet], siren' [lilac], shalfei [sage], liliya [lily], that also correspond to genera. More difficulty is presented by those vernacular names that, being nouns, would normally be associated with genera, but do in fact designate species, with different names sometimes referring to closely related species, e. g., moroshka, knyazhenika, and kostyanika [*Rubus chamaemorus*, *R. arcticus*, *R. saxatilis*]. It is quite impossible to associate these plants with three

different genera, while the use of such names as malina-moroshka or malina-kostyanka [malina, raspberry, apparently being suggested for the genus *Rubus* as a whole] would also be inconvenient. Here is a hint of a rupture between the scientific Latin and the Russian nomenclature; fortunately, however, there are few such instances and, on the whole, the Russian nomenclature, like the Latin, has a binary construction consisting of a substantive generic and an adjectival specific name.

In those instances when no Russian name was available, it was necessary either to translate the Latin name or, when translation appeared unsuitable, to make a straight Russian transliteration of the Latin name.*

As regards the actual presentation of the text of the "Flora": The text devoted to each species is divided into four paragraphs. The first gives the exact name, the synonyms, and citations of those works in which each of the names was first mentioned, and in addition, the very desirable citations from Ledebour, *Flora Rossica*; Turczaninov, *Flora Baicalensi-Dahurica*; Schmalhausen, *Flora srednei i yuzhnoi Rossii* (Flora of Central and Southern Russia); Krylov, *Flora Zapadnoi Sibiri* (Flora of Western Siberia); and N. I. Kuznetsov, *Flora Caucasica critica*. These works contain many accounts which cannot be restated in the "Flora of the USSR" due to space limitations. Moreover, it is necessary for specialists to know the names given to a plant in earlier floras. Inclusion of additional citations and of references to monographs, etc., is left to the discretion of the various authors.

The second paragraph provides the description of the species, as short and concise as possible, but expected to contain everything essential that may be of help in identification of the studied plant. At the end of the paragraph there is an indication of the months in which the flowering and fruiting of the species occur [these are designated by Roman figures in the original text and in full in the translation].

The third paragraph reports the habitats and the geographic distribution of the plant. The habitat deserves most careful attention as it is of enormous significance to the plant and has importance in attempts to introduce wild plants into cultivation. The geographic distribution within the Soviet Union is presented by most contributors according to the scheme outlined below. The authors have refrained from the use of administrative divisions, as these may easily change while the Flora is being composed, and have adopted as basis the general geographic terms: European part of the USSR, the Caucasus, Central Asia**, Western Siberia, Eastern Siberia, and the [Soviet] Far East. Within these main areas, further subdivision is based on large watersheds and mountain areas.

The fourth paragraph deals with the economic importance of plants. Strange as it may seem, until recently botanists have paid very little attention to the useful or harmful properties of plants. Provision of such information is nowadays imperative and the more of it is given, the better.

* [In actual fact, many of the less common Russian generic names appearing in the "Flora of the USSR" are transliterations of the scientific names. The specific Russian names, with rather few exceptions, are mere translations of the scientific names. The translator sees no point in retranslating such artificial creations and has therefore decided to omit the common names in translation. Wherever some additional notes appear in reference to nomenclature or where local names of special interest or picturesque connotation are mentioned, an attempt is made to render these comprehensible in the translation.]

** [i.e., Soviet Central Asia.]

The difficulty here consists in the fact that personal verification of the feeding, medicinal, technological, or other value of a given plant is seldom possible and one is obliged to borrow the necessary information from the literature, at second hand. A naturalist, accustomed to working with original material, has a feeling that he is not engaged in a serious pursuit when he has recourse to compilation. Nevertheless, compilation, provided it does not consist in mechanical transcription of information but is attended by a critical approach, is a perfectly justified activity and yields reliable information.

Such are unfortunately the limitations imposed by the scope of the "Flora of the USSR." Inclusion of more detail is possible only in local floras, where the smaller number of species permits allocation of more space to each of them.

At the end of the third paragraph, information is provided, wherever possible, as to the location from which the given species was described and the repository of the specimen or specimens on which the original description was based. Information concerning provenience makes it always possible to verify the correctness of the adopted specific name when old composite species are broken up into smaller species with definite geographic connotation. A record of repository is necessary when the need arises to check material against that originally described under a given name. Just how important this is may be seen from the fact that Japanese botanists have often received requests from Uppsala, where the herbarium brought by Thunberg from Japan is deposited, or from Leyden, where Micheli's herbarium is preserved, to ascertain which were in fact the plants designated by names given by these authors.

Since the contemporary flora of the earth is directly descended from the flora of the Tertiary period, our renowned phytopaleontologist A. N. Krishtofovich prepared for the "Flora of the USSR" a compendium of all records of Tertiary plants ever made on USSR territory. All these data are apportioned over the system and are reported at the head of corresponding families and genera, so that the reader may always easily make a confrontation of the past and the present. Finds relating to more ancient periods have not been included in the "Flora" as they have no direct bearing on contemporary plants.

IV

At a conference of geobotanists and taxonomists, the program of the "Flora of the USSR" was the subject of thorough discussion. As a result of the deliberations, the following principles have been laid down for the composition of the Flora.

1. The adoption of the systematic units and the classification of the material by families and genera should be imbued with the spirit of evolutionary science. The arrangement of the material within families and genera should as far as possible reflect the history of their formation. Engler's system is taken as a basis for the general arrangement of the material, while the order of genera follows the synopsis of Dalla-Torre and Harms, *Genera Syphonogamarum*.

- 11 2. The categories of species and genus are to be conceived in terms of the narrower natural interpretation, reflecting the genetic rather than the formal relationships of kindred organisms; the species being geographic formations, the genera being aggregates arising from divergence in the progeny of chief progenitors of a given group.
3. Not only the arrangement of the material, but also the construction of the keys and analytical tables, should be determined, beside considerations of convenience and practicality, by phylogenetic ties* and genealogy of the analyzed groups.
4. The characterization of families and genera should be short, with a view to conciseness and to the possibility of inclusion of new genera and species without prejudice to the conception of family and genus. One must also endeavor to ensure (especially with genera not yet critically treated) that the descriptions should reflect the body of species contained in the flora, and not be vaguely and generally applicable to all species of a given genus or that part of them which is generally associated with the Temperate Zone.
5. Confusion of generic and specific characters should not be allowed, i. e., genera ought to be described in such a way that changes in the number of species will not upset the described genus and its determination. It should be noted that generic characters are by nature different from specific characters.
6. The total number of species of a genus, which is but rarely finally determined, and the geographical distribution of the entire genus, are not given. Forms and varieties are not reported separately, but are referred to in passing in the descriptive text relating to the species, with author's name but without citation. Critical observations are admissible only in the form of very substantial and concise statements (if possible, not more than two lines).
7. Description of species should average not more than 1200 print characters, including all the information concerning a given species.
8. The description is provided in the following order: specific name, citations, synonyms, *Icones*, i. e., illustrations, *Exs.* — published standard specimens, Russian name, description, phenology, ecology, geographic distribution, type, and usefulness.
9. General distribution refers mainly to regions adjoining the USSR. Reports subject to doubt as regards specific identity are not included, even when quoted in the literature.
10. Reports of hybrids must be supported by an indication of authenticity.
- 12 Sporadically occurring hybrids are merely mentioned; those occurring more regularly, such as hybrids of *Salix*, *Cirsium*, etc., are described but not numbered; hybrids with a distinct distribution area, e. g., *Alnus pubescens*, are incorporated in the key and are listed with a number.
11. Each plant should be supplied with a Russian name, resembling as far as possible the binary scientific name. With a view to ensuring uniformity of the Russian nomenclature, it is desirable that, in composing and selecting Russian names, the following requests be complied with.

* This task is very difficult to accomplish, since the territory on which a given group developed often does not coincide with USSR territory and we have to be satisfied with mere fragments of the material that is required for elucidation of the phylogeny of the groups investigated.

A. A binary name is given whenever there is no single generally accepted name (malina [raspberry], ezhevika [dewberry], kostyanika [stone-bramble], chereshnya [sweet cherry], etc.); the specific name should, of course, not be identical with the generic.

B. For plants of economic importance, it is desirable to give also the Russian synonyms, e. g., for *Ficus carica* — smokva, figa, inzhir.

C. In formulating the Russian names, the aim should be a literary rather than a literal rendering of the Latin name, one that would convey the nature of the given plant; thus, *Cirsium eriophorum* — budyak sherstistyi [woolly] and not sherstenosnyi [wool-bearing], *Sedum acre* — ochitok edkii [pungent, acrid] and not ostryi [sharp], etc.

Widely distributed genera are given in this work their current literary names (*Rubus* — malina, *Hypericum* — zveroboi, *Ranunculus* — lyutnik, *Euphrasia* — ochanka, etc.); local genera (Caucasian, Siberian, Central Asian) are given, as far as possible, their local names, such as kendyr' [*Apocynum*], badan [*Bergenia*], saksaul [*Haloxylon*]; genera without any Russian or local name are named by translating the Latin name (*Polypodium* — mnogonozhka, *Struthiopteris* — strausoper, *Anemone* — vetrenitsa) or by transcription into Russian (*Aconitum* — akonit, *Paeonia* — pion, *Lilium* — liliya). Genera named for authors are also rendered in Russian transcription: Rudbekkiya, Vudsiya [*Woodsia*], Trautfetteriya.

12. Generic names are always capitalized, while specific names begin with a lower-case letter; thus, if included in the genus *Prunus*, the specific name of bird-cherry is written *Prunus padus*, but if referred to a separate genus of bird-cherries, then *Padus racemosa*. The old rule which provided for capitalization of substantive names of species was responsible for many misunderstandings and its adoption would be inexpedient. Only specific names derived from personal names and surnames may be written with a capital letter.

13. Cultivated plants are included in the "Flora" only insofar as they are widely adopted in large-scale cultivation or when easily naturalized. Only species are described; varieties and strains of cultivated plants are not mentioned, as these are the subject of a separate flora of cultivated plants that is being prepared by the Institute of Plant Cultivation.

V. Komarov

Division I. **ARCHEGONIATAE**

Archegoniatae or higher cryptogamous plants — Embryophyta
Asiphonogama, i. e., "plants with an embryo but with no pollen tubes,"
or Cryptogamae Vasculares, i. e., vascular plants reproducing by spores.

Rarely thalloid, mostly clearly differentiated into stem and leaves, with two alternating generations or developmental phases: (1) gametophyte or haploid, the cell nuclei having a simple chromosome complement; the sexual generation contributing the gametes, reproduction elements that are either sperm cells contained in antheridia or egg cells in archegonia; (2) sporophyte or diploid, resulting from fertilization of the egg cell by the sperm, the fusion of cell nuclei bringing about the doubling of the chromosome number, the plant itself producing spores at maturity. Prior to spore formation the chromosomes in the nuclei of mother cells fuse in pairs and their number is thus halved.

Subdivision I. **BRYOPHYTA**

(Mosses are not included in the present work; they are being worked on and will be published in due course in a series of cryptogamic floras).

Subdivision II. **PTERIDOPHYTA**

The gametophyte or prothallium leaflike or tuberlike, not differentiated into stem and leaves, absorbing water by means of rhizoids, producing archegonia and antheridia; the egg cell in the archegonium, upon fertilization by the sperm, forms the embryo that gives rise to a plant consisting of root, stem and leaves, all unified by a common vascular system; this plant, the sporophyte, forms sporangia on the leaves or more rarely at the leaf base; the spores in turn give rise to the gametophyte.

Key to Classes of Pteridophytes

1. Leaves with a strongly developed simple or compound blade (except the genera *Marsilia*, *Salvinia* and *Pilularia*, which see below); stem in USSR representatives of this class only underground (rootstock) or slender and floating Class I — **Filicales**.
- + Leaves small, scalelike, linear-lanceolate, or dentiform, mostly without a petiole 2.

2. Submersed plants with a tuft or rather long subulate ligulate leaves
 Class IV — **Isoetales** (p. 98).
- + Terrestrial plants or merely the stem immersed at base; stem well
 developed; spore-bearing leaves forming terminal spikes or sporangia
 borne in the leaf axils 3.
3. Stems distinctly jointed, with hollow internodes; leaves scalelike, acute,
 in regular whorls at the nodes Class II. **Equisetales** (p. 77).
- + Stems forking, not jointed; leaves spirally or dorsiventrally arranged,
 densely covering the stem throughout its length
 Class III. **Lycopodiales** (p. 86).

Note. According to the suggestion of the American scientist
 E. Ch. Jeffrey, the fernlike plants with the large and often much divided
 leaves and relatively undeveloped stem are separated into a distinct class—
 Pteropsida, while all other fernlike plants with inconspicuous leaves
 undifferentiated into petiole and blade, are together classified under the
 name "Lycopsida."

Class I. **FILICALES** *

Key to Families

1. Plants aquatic or creeping in mud; leaves simple, filiform or oval-
 elliptic or else palmately 4-parted; sporangia and spores of two kinds,
 macro- and microspores, inclosed in tight involucre [sporocarps];
 prothallia developing without vacating and only partially protruding
 from the spore (Order **Hydropteridineae**) 2.
- + Plants terrestrial or creeping in mud, but not aquatic; sporangia open,
 borne on the lower leaf surface, on the veins or at the margin 3.
2. Floating plants, without roots; leaves partly oval or orbicular, partly
 filiform rootlike and submerged Family IV. **Salviniaceae** (p. 69).
- + Bog plants with creeping rootstocks; leaves with a slender petiole and
 blade consisting of 4 cuneate-ovate lobes, circinate in veneration
 Family V. **Marsileaceae** (p. 70).
- 17 3. Sporangial ring [annulus] wanting or reduced to few cells with thickened
 walls; sporangia sessile or nearly so 4.
- + Sporangial ring well developed; sporangia stalked 5.
4. Leaves somewhat fleshy, not circinate in veneration, vaginate at base,
 consisting of a sterile posterior part and a fertile anterior part, this
 narrowly spiciform or paniculate; sporangia opening by a transversal
 cleft Family VI. **Ophioglossaceae** (p. 71).
- + Leaves not fleshy, the fertile and the sterile dissimilar; sporangial
 ring wanting, a group of thick-walled cells facilitating the opening of
 the sporangium; sporangia subspherical, short-stalked
 Family III. **Osmundaceae** (p. 67).
5. Leaves thin, mostly of a single layer of cells; annulus horizontal or
 oblique; sori marginal or terminal, borne on a columnar or bristlelike
 receptacle; indusia cupuliform or bivalvular
 Family I. **Hymenophyllaceae** (p. 15).

* Arranged by Academician A. V. Fomin (Kiev).

- + Leaves of many cell layers, circinate in vernation; annulus vertical, incomplete; sori on the underside of leaves, round, oval or linear, or borne on separate fertile leaves Family II. **Polypodiaceae** (p. 16).

Family I. **HYMENOPHYLLACEAE** SW.

Sporangia with a complete oblique or transversal annulus, opening by a longitudinal slit, borne on a columnar receptacle; spores tetrahedral or tetrahedral-globose; sori terminal or axial; indusium inferior, forming an urceolate often bivalvular sac.

1. Sori marginal or axillary; indusium univalvular, tubular, truncate, or scarcely bivalvular 1. **Trichomanes** L.
 + Sori marginal or terminal; indusium always bivalvular
 2. **Hymenophyllum** J. Smith.

Genus 1. **TRICHOMANES** L.

L. Gen. pl., ed. 2 (1743), 392; Prantl Hymenophyll. (1875) 54.

Sori marginal, borne on a columnar often bristlelike receptacle; indusia tubular or campanulate, univalvular, truncate at apex.

- 18 1. **T. parvulum** Poir. Enc. VIII (1808) 64; Nakai Tent. Syst. Hymenoph. Japon. in Botan. Mag., Tokyo XII, 262.— Ic.: Fomin in Fl. Sib. et Or. extr. 3.

A small dark green plant, 2—2.5 cm long; leaves flabellate, subfurcately lobed, in live condition often infundibularly rolled; petiole slender, as long as or longer than the blade; sori borne at the ends of middle lobes; indusia cup-shaped, with a narrow lip. July, August. (Plate I, Figure 2, a—e).

Damp rocks and tree trunks, among mossy undergrowth.— Far East: Uss. (Vladivostok Peninsula). **Gen. distr.:** Jap.-Ch., Malay Peninsula, islands of the Indian Ocean. Described from Madagascar. Type in Paris.

Genus 2. **HYMENOPHYLLUM** J. SMITH

J. Smith in Mem. Acad. Turin V (1793), 418; Nakai, l. c. 217.

Sori terminal or marginal, borne on a cylindric receptacle; indusium bivalvular, inclosing the sorus.

An authenticated fossilized representative of the genus *Hymenophyllum* was found among the Jurassic flora of L. Don. and in Pliocene layers of Transcaucasia (Goderskii Pass)—H. Fomini Palib.

1. **H. Wrightii** v. d. Bosch in Ned. kr. Arch., 4 (1859) 391;
 A. Krishtofovich, a find of *H. Wright* in Sakhalin, Izv. Bot. sada XXIX (1930) 412.— Ic.: Kom. and Alis., Opred. I, Plate 2.

A small plant with a slender filiform creeping rhizome; leaves thin, translucent, green or toward winter rest reddish-brown, the rachis narrow-winged, the segments forking and confluent; sori borne on a short receptacle; indusia 2-valved, the valves round or oval, entire. (Plate I, Figure 1 a, b).

Tree trunks and andesite rocks, in dense spruce-and-fir forests.—
Far East: Sakh. (W. coast). **Gen. distr.:** Jap. Described from Japan.
Type in Leningrad.

Family II. **POLYPODIACEAE** R. BR.

Sporangia mostly long-stalked; annulus vertical, incomplete; spores
rounded-tetrahedral or bilateral.

In addition to extant genera, some extinct genera have been found in Tertiary layers of the USSR,
such as *Chrysodium* Mett. of the subfamily Acrosticheae.

Key to Subfamilies

1. Sori borne on a receptacle into which enter tracheids 2.
- + Sori without receptacle supplied by tracheids 4.
2. Sori developing in indusia forming cup-shaped conceptacles at the
margin of leaf segments 3. **Davallieae** (p. 39).
- + Indusia different in shape or wanting 3.
3. Indusium inferior, attached under the sorus; margins of frond
sometimes revolute; stipe jointed or not so 1. **Woodsieae** (p. 16).
- + Indusium superior, attached at the top, at center or at the side of the
sorus; leaf margins not revolute; stipe not jointed
. 2. **Aspidieae** (p. 24).
4. Indusium nearly always evident, commonly attached at the side of sori;
frond margins sometimes revolute; stipe not jointed
. 4. **Asplenieae** (p. 40).
- + Indusium rudimentary or wanting 5.
5. Sori terminal or distributed along the veins of fertile fronds, oblong or
linear; leaf margins often reflexed, covering the sori; stipe not
jointed 5. **Pterideae** (p. 56).
- + Sori at the middle or at the ends of veins on fertile fronds; indusia
wanting; stipe jointed 6. **Polypodieae** (p. 65).

Subfamily 1. **Woodsieae** Diels.

Key to Genera

1. Fertile leaves more or less brown, more densely pinnate and differing
from the sterile 2.
- + Fertile leaves green, loosely pinnate 3.
2. All leaves rolled into a funnel, the fertile pinnatifid
. 5. **Struthiopteris** Haller
- + All leaves scattered on a creeping rhizome, the fertile bipinnate
. 6. **Onoclea** L.
3. Indusia ovate, pointed, vaulted like a hood, attached at one side under the
sorus 4. **Cystopteris** Bernh.
- + Indusia saucer-shaped, often fringed or dissected, attached by the base
all around the sorus 3. **Woodsia** R. Br.

Genus 3. **WOODSIA** * R. BR.

R. Br. in Transact. Linn. Soc. of London XI (1815) 170.

Sori borne at the ends of veins; receptacle somewhat raised; indusium saucer-shaped, dissected into capillary segments or entire, subglobular, membranous, bursting irregularly into lacerate divisions.

1. Stipes not jointed; indusia spherical 2.
- + Stipes distinctly or obscurely jointed; indusia dissected into capillary segments or irregularly lacerate 3.
2. Leaves lanceolate, glandular, the stipe and the midveins of frond segments covered with jointed hairs 1. **W. fragilis** (Trev.) Moore.
- + Leaves linear-lanceolate, glabrous 2. **W. manchuriensis** Hook.
3. Stipes very slender, greenish or stramineous; small plants. 4.
- + Stipes rather stout, mostly brownish; somewhat larger plants 5.
4. Leaves narrowly linear, acuminate 7. **W. glabella** R. Br.
- + Leaves lanceolate, the pinnae pinnatisect 8. **W. gracillima** C. Christsens.
5. Indusia inflated, with lacerate margin 3. **W. macrochlaena** Mett.
- + Indusia divided into capillary segments 6.
6. The long filaments of the cup-shaped indusium mostly nidulately convolute 7.
- + Filaments of the indusium not convolute 9.
7. Leaves linear, pinnate, the falcately lanceolate segments conspicuously auriculate at base 4. **W. polystichoides** Eaton.
- + The lanceolate frond subbipinnate 8.
8. Pinnae short, triangular-oblong, obtuse, subcordate at base 5. **W. subcordata** Turcz.
- + Pinnae triangular-oblong, wavy sinuate 6. **W. sinuata** Christ.
9. Pinnae deltoid-oval, with 2—4 pairs of lobes, glabrate 9. **W. alpina** Gray.
- + Pinnae with 8—20 pairs of lobes; plants densely covered with brown trichomes. 10. **W. ilvensis** R. Br.

Section 1. **PHYSEMATIUM** (Kaulf.) Diels in Engl. u. Prantl Pflz. 1, 4 (1902) 161.—Stipes not jointed; indusium globular, scarious, initially closed, at length bursting.

1. **W. fragilis** (Trev.) Moore Ind. Fil. (1857) 101; Shmal'g. II, 696; Fom. in Fl. Cauc. crit. I. 1, 7.—*Physematium fragile* Knze. Anal. Pteridogr. (183); Ldb. Fl. Ross. IV, 512.—*Hymenocystis caucasica* C. A. M. Verz. (1831) 229.—*Dicksonia fragilis* Trev. Ges. Nat. Freund Berl. VII (1816) 155, tab. III, f. 18.—Exs.: HFR, No. 850.

Perennial; leaves lanceolate, thin, short-stipitate, bipinnate, the stipe glandular-puberulous and hairy; pinnae lanceolate; lobes oblong, confluent at base, crenate-dentate; sori 4—6 per pinnule; indusium saccate, opening by 2 lips. July—September.

Calcareous rocks in the alpine and subalpine zones.—Caucasus: Cisc., Dag., E. Transc. **Gen. distr.:** Endemic. Described from Narzan vicinity.

* Named for the English botanist Joseph Woods (1778—1864).

2. *W. manchuriensis* Hook. 2 Cent. of Ferns (1861), t. 98; Fom. in Fl. Sib. et Or. Extr. V (1930) 9.— Ic.: Hook. l. c.

Perennial; leaves glabrous, narrowly lanceolate, pinnatipartite, 15–20 cm long, thin, short-stipitate; pinnae sessile, alternate, lanceolate, subobtusely lobed, sinuately or obtusely crenate; sori above the middle of vein ramifications; indusium light gray, with scattered unicellular glands, splitting into radiating segments; spores subglobose, brown, minutely granulose. August, September.

Rocks in mixed and oak woods.— Far East: Uss., Ze.-Bu. **Gen. distr.:** Jap.-Ch. Described from the coast near Vladimir Bay. Type in London.

Section 2. **INTERMEDIAR** Fom.— Stipe faintly jointed about the middle and breaking off at the joint or distinctly jointed; indusium globular, the filaments nidulently convolute.

3. *W. macrochlaena* Mett. ex Kuhn in Journ. of Botany VI (1868) 270.— Ic.: Fom. in Fl. Sib. et Or. Extr. V (1930) 11.

Perennial; leaves oblong-lanceolate, bipinnate; joint of stipe forming a beveled annular ridge at the frond base; vestiture of pointed articulate hairs; pinnae oblong-lanceolate; pinnules oval, crenulate; sori globular, subcoriaceous, reticulate-rugose. August, September. (Plate I, Figure 5 a–c).

Rocks.— Far East: Uss. (Slavyanka). **Gen. distr.:** Jap.-Ch. Type in Leningrad.

4. *W. polystichoides* Eaton in Proc. Am. Acad. IV (1858) 110.— Ic.: Fedch. and Fl., Opred. rast. Sib. (1909) 8, Figure I; Fom. in Fl. Sib. et Or. Extr. V (1930); Kom. and Alis., Opred. I (1931), Plate 3.

Perennial; leaves linear-lanceolate, to 30 cm long, pinnate; stipe brownish, with a distinct annular joint about the middle; pinnae lanceolate, auriculate at the upper margin; underside of frond and stipe chaffy; sori at the ends of veins; indusium with long arched-incurved filaments; spores ellipsoid, reticulate. August.

22 Rocks in woods; rarely stony wooded slopes.— Far East: Ze.-Bu., Uss., Sakh. **Gen. distr.:** Jap.-Ch. Described from Japan.

5. *W. subcordata* Turcz. in Bull. Soc. Nat. Moscou, V (1832) 206.— Ic.: Fom. in Fl. Sib. et Or. Extr. V (1930) 13.

Perennial; leaves 6–16 cm long, lanceolate, pinnipartite, covered with trichomes and chaff; pinnae oval-oblong from a cordate base, obtuse, the margin sinuate-wavy; indusium divided into slender filaments nearly down to base; spores ovaloid, netted-plicate. June–October. (Plate I, Figure 4 a–c).

Basaltic and schistose rocks on river banks, exposed to the sun.— Far East: Ze.-Bu., Uss. **Gen. distr.:** E. Mongolia, Manchuria, Korea, N. China. Described from Mongolia. Type in Leningrad.

6. *W. sinuata* (Hook.) H. Christ in Bull. Herb. Boiss. 2 ser. II (1902) 830.— *W. polystichoides* var. *sinuata* Hook. Gard. Ferns (1862) tab. 32, f. 3.— Ic.: Hook., l. c.

Perennial; leaves lanceolate, to 15—17 cm long and 2—3 cm broad; stipes brown, sparsely covered with chaff and trichomes; pinnae oblong, subobtusate, the lower pinnately divided, the upper deeply incised-sinuate, rounded at base; sori between the midvein and margin of segments; veins on the upper surface of the frond clavately thickened; indusia and spores resembling those of the preceding species. August, September.

Rocks in woods.— Far East: Uss. **Gen. distr.:** Jap.-Ch. Described from China.

Note. The last two "species" are most likely of hybrid origin, derived from *W. ilvensis* A.Br. and *W. polystichoides* Eaton. According to V. Komarov, however, they are different species. Their descriptions are given with a view to stimulating more detailed investigations.

Section 3. **EUWOODSIA** R.Br.— Stipes jointed; indusium irregularly divided into filaments nearly down to base.

7. **W. glabella** R.Br. in Richards. in Franklin, Narr. of Journey to the Shores of the Polar Sea by Capt. Franklin, Botany (1823) 754; Ldb. Fl. Ross. IV, 511; Kryl., Fl. Zap. Sib. 1, 14.— Ic.: Milde in Nov. Acta Leopold XXVI, 2, tab. 43, f. 104; Luer. Farnpfl. f. 119; Kom. and Alis., Opred. (1931), Plate 4.— Exs.: Plantae Finland. No. 407.

Perennial; leaves linear, acuminate, pinnatisect, 4—6 cm long and to 8 cm broad, short-stipitate; lower pinnae rounded, subentire, sometimes all orbicular (var. *rotundata* Fom.)*, the middle pinnae rhomboid, or oblong-oval (var. *heterophylla* Turcz.), often cleft to the base into oval-cuneate or flabellate lobes, or the lower pinnae deeply lobed, the middle and the upper deeply pinnatifid (var. *pinnatifida* Fom.); plants glabrous throughout, rarely with scattered trichomes; sori covering the entire lower surface of the segments; spores wrinkled. August.

Calcareous or rarely granite rocks.— European part: Kar.-Lap., Dv.-Pech.; W. Siberia: Ob, Alt.; E. Siberia: Ang.-Say., Lena-Kol.; Far East: Ze.-Bu., Uss. **Gen. distr.:** Arc., Scand., mountains of S. Eur. Described from the Great Bear Lake area in North America.

8. **W. gracillima** C. Christens. Pl. sinenses a d-re H. Smith 1921—22 lectae, Plate XVI, Särtryck ur Medd. från Göteb. bot. Trädgård 1 (1924) 42.

Perennial; leaves thin; stipes to 2 cm long, stramineous; fronds lanceolate, narrowed at both ends, 5—10 cm long, 1—2 cm broad, glabrous; pinnae deltoid, pinnatisect, with dissected narrowly cuneate lobes; sori 1—3 on each lobe.

Rocks in China. Not found so far in the USSR, but possibly occurring in the Far East. Described from China.

9. **W. alpina** (Bolton) Gray Natur. arrang. of brit. pl. II (1821) 17.— *W. hyperborea* α *arvonica* Koch Syn. Fl. Germ. ed. II, 975.— *W. ilvensis* var. *alpina* Asch. u. Graebn. Syn. 1, 46; Kryl., Fl. Zap. Sib., 1, 13.— *W. hyperborea*. Ldb. Fl. Ross. IV, 511.— *W. pilosella* Rupr. in Beitr. z. Pflanzk. d. R. Reiches III (1845) 54; Ldb. Fl. Ross. IV,

* Fomin in Fl. Sib. i Dal'n. Vost. (Flora of Siberia and the Far East) maintains that var. *rotundata* corresponds to *W. asplenioides* Rupr. in Beitr. z. Pflanzenk. d. Russ. R., III, 55; Ldb., Fl. Ross. IV, 511, described from Dauria.

511.— *Acrostichum alpinum* Bolt. Fil. brit. (1790) 76, t. 42.—
 Ic.: Fom., Fl. Ukr. 1, Plate 1; Luer. Die Farnpfl. 505, f. 167.

Perennial; leaves oblong-lanceolate, bipinnatifid, subobtusate, more or
 less hairy when young, becoming glabrous; stipes yellowish-brown; pinnae
 with 3 or 4 pairs of oval-cuneate lobes; sori almost covering the entire
 lower surface; spores coarsely rugose. July, August.

Granite and nepheline rocks.— European part: Kar.-Lap., V.-Ka.
 (Il'men Mts.), Bl. (Berdiansk-Mariupol area); W. Siberia: Ob, Alt.;
 E. Siberia: Yen., Lena-Kol. **Gen. distr.:** Arc. Eur., Atl. Eur., mountains
 of Centr. Eur., N. Am. Described from England. Type in London.

10. *W. ilvensis* R. Br. Prodr. Pl. Nov. Holl. I, (1819) 158; Ldb. Fl.
 Ross. IV, 510; Shmal'g. II, 696.— *W. hyperborea* β *rufidula* Milde
 Filices Eur. (1867) 164; Kryl., Fl. Zap. Sib. I, 13.

Perennial; leaves oblong-lanceolate, 6—20 cm long, covered on both
 sides with brown chaff and long brown articulate trichomes; stipe brown,
 lustrous; pinnae 8—20 pairs, pinnatifid, with 5—8 pairs of oval lobes;
 sori confluent; spores elliptic, with reticulately trabeculate outer wall.

24 Granite and other mountain rocks.— European part: Lad.-Ilm.,
 Dv.-Pech., V.-Kama, U. Dnp., M. Dnp.; W. Siberia: Ob, Alt.; E. Siberia:
 Yen., Ang.-Say., Lena-Kol., Dau.; Far East: Ze.-Bu., Uss., Okh.,
 Kamch., Sakh.; Centr. Asia: Dzu.-Tarb. **Gen. distr.:** Centr. Eur.
 Described from Europe. Type in London.

Genus 4. **CYSTOPTERIS** * BERNH.

Bernh. in Schrad. New Journ. 1, 5 (1806), 26.

Sori roundish, borne on the back of the veins; indusium scarious, round
 or oval, pointed, attached at the base of the sorus and covering it like a
 hood; stipe not jointed.

1. Rhizome slender, long and creeping 2.
- + Rhizome relatively stout, short, horizontal 3.
2. Frond triangular; lowest pinnae asymmetrically ovate; first pinnule
 on the lower side longer than the next . . . 4. *C. montana* (Lam.) Bernh.
- + Frond ovate-triangular; lowest pinnae slightly asymmetric; lowest
 pinnule on the outer side shorter than the next 5. *C. sudetica* A. Br. et Milde.
3. Spores covered with obtuse warts; frond lanceolate or narrowly
 lanceolate, covered with scattered unicellular glands and articulate
 hairs 3. *C. Dickieana* Sim.
- + Spores covered with minute needles 4.
4. Frond linear-lanceolate, the third-order lobes emarginate and rather
 narrow, their veins terminating between the teeth 2. *C. regia* (L.) Presl.
- + Frond oblong, the veins of third-order lobes terminating in the teeth or
 apparently excurrent between the lobules of the tooth 1. *C. fragilis* (L.) Bernh.

1. *C. fragilis* (L.) Bernh. in Schrad. Neu. Journ. f. Bot. 1, 2 (1806) 26;
 Ldb. IV, 515; Kryl., Fl. Zap. Sib. 1, 15; Shmal'g. II, 695.— *Polypodium*

* From Greek cyste, bladder, and pteris, fern, referring to shape of indusium.

fragile L. Sp. pl. (1753) 1091.— Ic.: Moore et Lindl. Brit. Ferns tab. 45; Luer ss. Farnpfl. 457, f. 156.— Exs.: HFR, No. 1649, a and b.

25 Perennial; fronds tufted, thin, oblong, nearly thrice pinnatifid; stipes slender, brownish; pinnae pedicellate, oblong, the lowest shorter than the next; pinnules oblong, dissected into round- or cuneate-based toothed lobes; teeth at the margin of segments short, acute or obtusish, the vein ramifications ending in the apices (var. *anthriscifolia* Koch) or else the teeth more elongated, obtusely truncate or retuse, the veinlets terminating in the notch or at the middle of the obtuse trim (var. *emarginato-denticulata* Fom.); sori borne in a row on either side of the midvein of the pinnule; indusia oval-lanceolate, inflated; spores softly echinulate. July, August. (Plate I, Figure a—c).

Rocks and scarps.— European part: from Kar.-Lap. and Dv.-Pech. to the steppes of Crimea; Caucasus: Cisc., W. Transc., E. Transc., S. Transc., Tal.; W. Siberia: Ob, U. Tob.; Centr. Asia: Dzu.-Tarb., Mtn. Turkm., Pam.-Al., T. Sh.; E. Siberia: Yen., Ang.-Say., Lena-Kol., Dau.; Far East: An., Okh., Uss. **Gen. distr.:** Scand., Atl. Eur., Centr. Eur. Described from N. Europe. Type in London.

Note. Young leaves have the scent of bitter almonds; the spores contain prussic acid.

2. **C. regia** (L.) Presl. Tent. Pteridogr. (1836) 93; Fom. in Fl. cauc. crit. 1, 23.— *C. fragilis* b. *alpina* Milde Sporenpl. (1865) 68.— *Polypodium regium* L. Sp. pl. (1753) 1091.— Ic.: Luer ss. Farnpfl. 465, Figure 160.— Exs.: Wirtgen Pterid. exs. No. 506.

Perennial; differs from the preceding species in the more dissected, thrice pinnate frond and shorter stipe; pinnules linear or narrowly lanceolate, the nerve ending between the teeth; spores echinulate. July, August. (Plate I, Figure 9 a—c).

On limestone in the alpine zone.— Caucasus: Gr. Cauc. **Gen. distr.:** mountains of Centr. Eur. Described from France. Type in London.

3. **C. Dickieana** Sim. Gard. Journ. (1848) 308.— *C. fragilis* var. *Dickieana* Moore, Nature printed brit. Ferns II, 256.— *C. Baenitzii* Doerfl. in Baenitz Herb. europ., No. 6510 (1891).— Ic.: Moore, l. c., tab. 102, B.— Exs.: Baenitz, No. 6510.

Perennial; fronds oblong obtuse to narrowly lanceolate acuminate; pinnae oval or oblong-oval; pinnules mostly obtuse; rachis and veins more or less covered with articulate hairs terminating in a brown inflated ovaloid-cupuliform gland, these interspersed with unicellular brown glands; spores verrucose. July-August. (Plate I, Figure 3 a—c).

Calcareous and schistose rocks.— Arc.: An.; W. Siberia: Ob; E. Siberia: Lena-Kol., Yen., Ang.-Say. **Gen. distr.:** Arctic belt of Europe and Siberia. Described from Scotland.

4. **C. montana** (Lam.) Bernh. in Schrad. Neu. Journ. f. Bot. 1, 5 (1806) 26; Link Hortus Berol. II (1833) 131; Ldb. Fl. Ross. IV, 517.— *Polypodium montanum* Lam. Fl. Fr. 1 (1778) 23.— Ic.: Moore Nat. print. Brit. Ferns II, tab. 104; Luer ss. Farnpfl. f. 161; Fedch. and Fl., Oprod. rast. Sib. 1, Figure 6.— Exs.: HFR, No. 1550.

26 Perennial; rhizome creeping, branching; fronds triangular or triangular-oval, 3- or 4-pinnatifid; stipe 2—3 times as long as the frond, sparsely



Plate I

1. *Hymenophyllum Wrightii* v. d. Bosch.: a) general aspect; b) plant fragment.—
 2. *Trichomanes parvulum* Poir.: a) general view; b) open sori with sporangia; c) indusium of unopened sori; d) spores; e) leaf with sporangium.— 3. *Cystopteris Dickieana* Sim.: a) underside of pinnule with sori; b) gland-tipped articulate hairs; c) spores.— 4. *Woodsia subcordata* Turcz.: a) general aspect; b) underside of pinna with sori; c) sori; d) spores.— 5. *W. macrochaena* Metten.: a) general aspect; b) underside of pinnule with sori; c) sori with coriaceous indusium.— 6. *Struthiopteris filicastrum* All.: a) pinna; b) fertile leaf segments with sori; c) open sori.— 7. *Polystichum craspedosorum* Diels: a) underside of a segment of a pinnule with sori; b) sori in section; c) indusium.— 8. *Cystopteris fragilis* Bernh.: a) underside of a leaf segment; b) and c) indusium.— 9. *C. regia* Desv.: a), b) and c) leaf segment shapes.

chaffy; rachis and its ramifications covered with short hairs and scattered glands; lower pinnae asymmetric; lowest pinnule on the outer side longer than the next; sori in 2 rows on the segments of the third order; indusium naked or glandular; spores obtusely aculeolate. July, August.

Rocks and stones in the forest zone.— European part: Kar.-Lap., Lad.-Ilm., V.-Kama; Caucasus: Gr. Cauc.; W. Siberia: Ob (Urals at Sosva), Alt.; E. Siberia: Yen., Ang.-Say. **Gen. distr.:** mountains of Centr. Europe. Described from Germany.

5. **C. sudetica** A.Br. et Milde in Jahresber. d. Schles. Gesellsch. f. vaterl. Cult. (1885) 92; Kryl., Fl. Zap. Sib. I, 18.— Ic.: Milde Nov. Acta Leopold. XXVI, 2, tab. 44, f. 109; Luer ss, l. c., f. 162.

Perennial; rhizome creeping; leaves broadly oval or oval-deltoid, acuminate, tripinnatifid, eglandular; stipe long; pinnae loosely spreading, oval acuminate to oblong-lanceolate and pointed; the lowest pinnule on the outer side shorter than the next; segments of the third order cuneate from a narrow base, dissected, the veins entering into the notched teeth; indusium glandular; spores with short obtuse prickles. August.

Rocks and dry slopes in the forest zone.— European part: Kar.-Lap., Dv.-Pech.; W. Siberia: Alt., Irt.; E. Siberia: Ang.-Say., Lena-Kol.; Far East: Ze.-Bu., Uss.; Caucasus: Cisc. (Kuban). **Gen. distr.:** mountains of Centr. Europe. Described from Silesia.

Genus 5. **STRUTHIOPTERIS** * HALLER

Enum. pl. Gött. (1753) 1.

Sori round, borne on swellings of the veins; indusium lacerate at margin, early caducous; leaves dimorphous, the sterile bipinnate, the fertile short, brown, developing within a funnel formed by the green leaves.

1. **S. filicastrum** All. Fl. Pedem. (1785) 283.— *Osmunda struthiopteris* L. Sp. pl. (1853) 1066.— *Onoclea struthiopteris* Hoffm. Deutsch. Fl. II (1795) 12.— *Struthiopteris germanica* Willd. Enum. pl. (1809), 1071.— *Matteuccia struthiopteris* Todaro, Syn. pl. Sic. (1866) 30.— Ic.: Luer ss. Farnpfl., Figure 164; Maevsk., Fl. Sr. Ross. (1917), Figure 296.— Exs.: HFR, No. 250.

Perennial; stock erect, thick, with underground offshoots; sterile leaves green, with a broadly oblong acute bipinnate frond and a short stipe; pinnae linear-lanceolate, acuminate, sessile; pinnules obliquely oblong-linear, obtuse, entire, tightly contiguous, with simple feathery venation; fertile leaves brown, pinnate, with subcylindric segments; spores elliptic, the outer coat with anastomosing folds. August, September. (Plate I, Figure 6 a—c).

Riverside woods, riverbank brush, alder groves, etc.— European part: Kar.-Lap., Dv.-Pech., V.-Kama, Lad.-Ilm., U. Dnp., M. Dnp., V.-Don, Transv.; Caucasus: Cisc., Dag., W. Transc., E. Transc.; W. Siberia: Ob, Alt.; E. Siberia: Yen., Ang.-Say., Dau.; Far East: Zu.-Bu., Uss., Sakh., Kamch. **Gen. distr.:** nearly all Europe, Med., N. Am., Japan. Described from Sweden. Type in London.

* From Greek *struthion*, ostrich, and *pteris*, fern.

Economic importance. An ornamental plant, harmful to livestock. A rootstock infusion serves as a popular vermifuge and was used in the past against bedbugs.

Genus 6. **ONOCLEA** * L.

Sp. pl. (1753) 1062.

Sori round, globular, at length confluent, borne on a cylindric receptacle; indusium inferior, subspherical, bursting and soon caducous; spores bilateral.

A species of *Onoclea* was found in Tertiary layers along the Ashutas River in the Lake Balkhash area.

1. **O. sensibilis** L. Sp. pl. (1753) 1062; Fom. Fl. Sib. et Or. Extr. 5, 41.— Ic : Kom. and Alis., Oprod. 1, 63, Plate 6.

30 Perennial; rhizome long and creeping; stipes triquetrous, naked, longer than the frond; fronds delicate, naked, light green, deltoid or oval-deltoid, pinnatifid; pinnae lanceolate to linear-lanceolate, pinnatifid or sinuate; pinnules oval to oval-triangular, somewhat pointed; fertile fronds compactly pinnatifid, their frond erect linear, the pinnules globose; sori in a row on either side of the midvein; indusium inferior, splitting, with sinus at the free margin. July, August.

Wet meadows and riverbank brush, e. g., osier beds.— Far East: Ze.-Bu., Uss., Sakh. **Gen. distr.:** N. Am., Jap.-Ch. Described from Washington State. Type in London.

Subfamily 2. **Aspidieae** Diels

Key to Genera

1. Indusium round, peltate, centrally attached to sorus; leaves more or less coriaceous; pinnules with aristate teeth, auriculate 8. **Polystichum** Roth.
- Indusium cordate or reniform, laterally attached at the sinus, or wanting; leaves rather soft 7. **Dryopteris** Adans.

Fossilized species found in the USSR include *Dryopteris stiriaca* (Ung.) Palib. in the Pliocene of W. Transcaucasia (Goderskii Pass) and *D. mediterranea* Fom. in the Pliocene of E. Georgia (Shiraki). A fern closely related to *Dryopteris*, of the species *Aspidium Meyeri* Heer, was found in Tertiary layers of Sakhalin (Mgach), in Arctic Siberia (Novosibirskie Is.), and the Pliocene of W. Transcaucasia (Goderskii Pass).

Genus 7. **DRYOPTERIS** ** ADANS.

Fam. d. pl. (1763) 20.

Sori round, arranged in rows or scattered; indusia mostly cordate or reniform, laterally attached by a fold, sometimes shrivelling; stipes not jointed, the fronds 2- or 3-pinnatifid.

* Borrowed from Greek and designating donkey feed; name transferred to this plant from some weed.

** From Greek *drys*, oak, and *ptēris*, fern, i. e., fern of oak woods.

D. filix mas. Sw. was found in interglacial layers of U. V. (Likhvin) in fossilized condition;
A. sp. was discovered in the Pliocene of V.-Don (Krivoborsk).

1. Sori indusiate; indusium cordate or reniform and sometimes caducous at maturity; stipes rather stout; plants from 45 cm to 1 m tall, or even taller. 5.
- + Sori without indusium; stipe long and slender; plants 15—35 cm tall 2.
- 31 2. Leaves pinnate, cordate-oval or cordate-hastate, acuminate, covered on both sides with long hairs; pinnae deeply pinnatifid, the two lowest opposite and distant from others. 23. *D. phegopteris* (L.) C. Christens.
- + Leaves ternate, triangular, bipinnate, the lower segments petiolate 3.
3. All three divisions of the leaf of equal size. 4.
- + Terminal leaf division larger than the lateral; sori more or less approximate; dark green plants with glandular hairs 22. *D. Robertiana* (Hoffm.) C. Christens.
4. Plant naked; terminal leaf division not larger than the lateral; sori distant 20. *D. Linnaeana* C. Christens.
- + Plant glandular; terminal leaf division somewhat larger than the lateral 21. *D. continentalis* Petr.
5. Indusia persistent; sori borne on one of the ramifications of the forking lateral vein of segments 6.
- + Indusia not persistent; sori borne on both ramifications of the forking lateral vein of pinnules 22.
6. Teeth of pinnules and their segments abruptly terminating in a long soft mucro or gradually tapering to a short mucro and the leaves delicate in texture or, if teeth simply pointed, then leaves coriaceous 7.
- + Teeth of pinnules and their segments simply pointed or obtusish 17.
7. Fronds more or less coriaceous, often glandular, rarely naked 8.
- + Fronds rather thin-textured. 11.
8. Leaves linear-lanceolate, bipinnatifid, stiffly coriaceous, densely beset with sessile glands; stipes short; rachis chaffy beneath with dark brown imbricated scales; teeth thickened; indusia inflated. 10. *D. fragrans* (L.) Schott.
- + Leaves oblong or oval-oblong. 9.
9. Leaves bright green, subcoriaceous, not lasting through winter; frond and stipe glandular. 10.
- + Leaves stiffly coriaceous, wintering, pruinose but almost glandless; pinnae lanceolate, abruptly tapering to a point; chaff light brown, with a dark brown spot at the middle of each scale . . . 13. *D. Raddeana* Fom.
- 32 10. Pinnules sessile, rounded-oval, confluent, the margin with spreading teeth; indusia eglandular. 12. *D. Komarovi* Koss.
- + Pinnules oblong, pinnately lobed, short-petioled; indusia glandular. 11. *D. rigida* (Hoffm.) Und.
11. Teeth terminating in a thickish tapering tooth, this sometimes hooked and incurved toward the margin of the segment; lower pinnae triangular in outline from a cordate base, obtuse; other pinnae ovate; sori large 14. *D. cristata* (L.) A. Gray.
- + Teeth abruptly passing into a rather long slender soft bristle 12.
12. Leaves broadly deltoid or pentagonal, subternate; lobules and their segments covered beneath about the middle with small inflated bladderlike scales 19. *D. amurensis* H. Christ.

- + Leaves oblong, deltoid or linear-oblong, destitute of inflated scales 13.
13. Leaves dark green, tripinnatifid, with an unpleasant odor even in dry condition; stipe black, turning dark brown in drying, chaffy, the chaff of large lanceolate or capillary scales; stipe and frond covered with flask-shaped glands 17. *D. Alexeenkoana* Fom.
- + Leaves green or light green 14.
14. Pinnae strongly elongated at the ends, prolonged into caudiform tips 15.
- + Pinnae not tail-tipped 16.
15. Pinnules more or less distant, curved in toward the tips of the pinnae; plants light green; leaves glaucescent beneath; spores tuberculate 18. *D. laeta* (Kom.) C. Christens.
- + Pinnules as in the preceding species, but plants grayish-green; spores covered with tubercles and winged ribs 18. *D. wladivostokensis* B. Fedtsch.
16. Chaff on stipes of broad, oval, unicellular light pink scales; leaves mostly bipinnate, the lowest pinnae distant from the rest. 15. *D. spinulosa* (Müll.) O. Kütze.
- + Chaff on stipes of lanceolate or oblong-lanceolate strongly pointed scales with light periphery and dark brown center; leaves 3- or 4-pinnatifid, often glandular 16. *D. austriaca* (Jacq.) Woyнар.
- 33 17. Leaves coriaceous, bipinnate, persisting through winter; stipes stoutish; indusia coriaceous, vaulted, enveloping the sorus 18.
- + Leaves soft, not wintering; indusia scarious 19.
18. Pinnules linear, subentire, obtusely truncate or rounded at apex, sometimes with obtuse rounded denticles; sori at the middle of vein; stipe densely covered with ferruginous-brown or rufous chaff 5. *D. mediterranea* Fom.
- + Pinnules linear, slightly attenuate toward apex, slightly crenulate; sori on an abbreviated prong of lateral vein; chaff at the base of stipe mostly dark brown 4. *D. Buschiana* Fom.
19. Indusium inflated, enveloping the sorus 20.
- + Indusium not enveloping the whole sorus 21.
20. Leaves oblong-lanceolate, narrowed toward base, light green with a very short petiole and a dense coating of stramineous-brown chaff; rachis, margin, and veins beneath covered with narrow chaffy scales and hairs 8. *D. oreades* Fom.
- + Leaves as in the preceding, but veins of pinnules concave on the upper side; vestiture denser, of slender hairs; scales on stipe setiform 9. *D. barbellata* Fom.
21. Marginal teeth of pinnules acute; leaves soft, herbaceous; indusium not enveloping the sorus and covering it from above 6. *D. filix mas* (L.) Schott.
- + Teeth and lobes of segments rounded obtusish; frond subcoriaceous; indusium small 7. *D. sichotensis* Kom.
22. Frond narrowing toward base, oblong-lanceolate or oblong; rhizome short, upright 23.
- + Frond not narrowing toward base, linear-lanceolate; stipe long, black at base; rhizome long, slender, creeping, black; pinnae narrow, linear-lanceolate; pinnules entire, subacuminate; sori at or below the middle of simple or forking lateral veins, the margin of segments rolled in above the sori. 1. *D. thelypteris* (L.) A. Gray.

23. Chaff of rachis slightly developed; fronds rather densely glandular . . .
 2. **D. oreopteris** (Ehrh.) Maxon.
 + Rachis densely hairy; fronds eglandular; stipes chaffy with lanceolate
 long-acuminate rusty scales 3. **D. kamtschatica** Kom.

1. **D. thelypteris** (L.) A. Gray, Man. ed. I (1848) 630; Kryl., Fl. Zap. Sib. I, 21.—*Thelypteris palustris* Schott Gen. Fil. (1810) 10.—
 34 *Nephrodium thelypteris* Desv. Ann. Soc. Linn. Paris, VI (1827) 257.—*Polystichum thelypteris* Roth Tent. Fl. Germ. III (1800) 77; Ldb. Fl. Ross. IV, 518.—*Aspidium thelypteris* Sw. in Schrad. Journ. II (1800) 40.—*Acrostichum thelypteris* L. Sp. pl. (1753) 1071.—Ic.: Hook. Brit. Ferns tab. 13; Moore et Lind. Brit. Ferns tab. 29.—Exs.: HFR, No. 100.

Perennial; rhizome slender, creeping, blackish; leaves 30—60 cm long, long-stipitate, commonly eglandular, smooth or covered with grayish pubescence (var. *pubescens* Laws.), linear-lanceolate to oblong-lanceolate, bipinnate; pinnae deeply pinnatifid, lance-linear in outline; hairy-margined lobes confluent at base; segments of sterile leaves linear-oblong, those of fertile leaves triangular-cordate due to reflexed margins; lowest segments of the median pinnae longer than the others; sori at the middle of ramifications of the forking vein; spores reniform-oval, crested. July.

Peat bogs, scrub bogs, wet meadows, and overgrown lake shores.—European part: Kar.-Lap., Dv., Pech. and other regions to the south as far as Crimea; Caucasus: Cisc., W. and S. Transc.; W. Siberia: Ob, Tob., Irt., Alt.; E. Siberia: Dau., Ang.-Say.; Far East: Kamch., Sakh., Uss.; Centr. Asia: Mtn. Turkm., Pam.-Al., T.-Sh., Dzu.-Tarb. **Gen. distr.:** S. Scand., Centr. Eur., Atl. Eur., Med., N. Am. Described from N. Europe. Type in London.

Economic importance. Taking part in peat formation. The rhizomes and roots provide a substrate for greenhouse orchid culture.

2. **D. oreopteris** (Ehrh.) Maxon Proc. Un. St. Nat. Mus. 23 (1901) 638.—*Aspidium oreopteris* Sw. in Schrad. II (1803) 279; Shmal'g., Fl. II, 694; Rupr. Distrib. 35.—*Polypodium montanum* Vogler Diss. Polyp. (1781).—*P. oreopteris* Ehrh. in Willd. Prodr. (1787) 292.—*Nephrodium montanum* Baker Syn. Filic. (1867) 271.—*Polystichum oreopteris* Lam. et DC. Fl. Fr. II (1805) 563; Ldb. Fl. Ross. IV, 513.—Ic.: Engl. Bot. tab. 1019; Hook Brit. Ferns tab. 14.—Exs.: Wirtgen Pterid. exs., No. 57 et 216.

Perennial; rhizome oblique, short and stout; leaves lance-oblong, narrowing toward base, light green, bipinnate, glandular beneath; rachis covered with stiff hairs and sparsely chaffy; pinnae lanceolate, acuminate, the oblong confluent segments entire or sometimes repand; lowest segments on the upper side slightly enlarged; lowest pinnae small, triangular; veins of segments simple or forking; sori submarginal near the end of the vein; spores brown, reniform-oval, minutely crested at the margin, the sides covered with conical warts; indusium soon caducous, glandular. July–September.

Woods, mostly in mountains.—European part: M. Dnp.; Caucasus: Gr. Cauc., S. Transc.; E. Siberia: Ang.-Say. **Gen. distr.:** W. Eur. from S. Scandinavia to Corsica, E. Med., N. Am. Described from Hesse.

Note. Characterized by a pleasant scent.

3. **D. kamtschatica** Kom. in Fedde Repert. XIII (1914) 84; Fl. Kamtsch. 1 (1927) 59. — **D. oreopteris** Maxon var. **Fauriei** Miyabe et Kudo Mater. Fl. Hokkaido (1916) 61. — **D. Christiana** Kodama in Tokyo Bot. Mag. XXXVIII (1924) 107. — Ic.: Kom. Fl. Kamtsch. I, tab. I.

Perennial; rhizome stout, oblique; leaves oblong-lanceolate, to 60–90 cm long, narrowing at both ends, glabrous, nerveless, bipinnate; pinnae narrowly lanceolate, tapering to a long pointed tip; pinnule linear-oblong, entire, mostly falcate, confluent at base; veins of pinnules feathery; sori on lateral vein ramifications, near the margin of segments; stipe densely covered with long-acuminate scales, these also spreading over to the rachis; indusium small, convex, early caducous; spores reniform-oval, echinulate. August, September.

Mountain woods up to the timberline. — Far East: Kamch. (village of Nachik). Described from Kamchatka. Type in Leningrad.

4. **D. Buschiana** Fom. in Fl. Sib. et Or. Extr. V (1930) 52 cum ic.

Perennial; rhizome stout, oblique; leaves to 1 m long and 15 cm broad, oblong; stipe densely covered with oval or lanceolate acuminate dark brown scales; frond bipinnate, coriaceous; upper and middle pinnae linear-lanceolate, the lower abbreviated, oblong; pinnules linear, sometimes slightly curved, attenuate and rounded at apex, the crenulate margin covered with capillary scales; rachis covered with dark ferruginous scales; lateral veins of pinnules once or twice widely forking; sori at the middle of vein ramifications, these not reaching the margin. August, September.

Mountain woods, along streams and on slopes. — Far East: Uss. Described from Lefu and Suchan. Type in Leningrad.

Note. A species related to **D. crassirhizoma** Nakai Catal. Sem. Tokyo (1920) 32, but distinguished by the absence of glands on the indusium and by the veins that do not reach the margin of segments. Nakai's species is common in the mountain forests of Korea.

5. **D. mediterranea** Fom. nomen novum. — **D. paleacea** (Moore) Fom. in Fl. cauc. crit. I, 1 (1911), 52. — Exs.: HFR, No. 1800.

36 Perennial; leaves large, to 1 m long, oblong, coriaceous, dark green above, pale green beneath, wintering; stipe and rachis densely covered with scales, these narrow, ferruginous or ferruginous-black (f. *rubiginosa* Fom.), blackish toward base; underside of fronds covered with capillary scales; pinnae lance-linear; pinnules approximate, rarely distant (f. *disjuncta* Fom.), linear, subopposite and nearly entire, truncate at apex, with indistinct remote obtuse teeth; veins of pinnules perucid, thickened at the ends and widely forking; sori slightly above the middle of vein ramifications; indusium coriaceous, enveloping the sorus; spores reniform, with anastomosing folds. July, August.

Shady woods. — Caucasus: W. Transc., Tal. Gen. distr.: Atl. Eur., Med. Described from the Caucasus. Type in Tiflis.

6. **D. filix mas** (L.) Schott Gen. fil., tab. 9 (1834); Kryl., Fl. Zap. Sib. 1, 22; Fom. in Fl. cauc. crit. I, 1, 38. — **Aspidium Filix mas** Sw. in Schrad. Journ. II (1800) 38; Shmal'g. II, 694. — **Polystichum Filix mas** Roth Tent. Fl. Germ. III (1800) 82; Ldb. Fl. Ross. IV, 514. — **Nephrodium Filix mas** Rich. Cat. med. (1801) 120. — **Polypodium Filix mas** L. Sp. pl. (1753) 1090.

Perennial; rhizome stout, oblique; leaves to 1 m long; stipe shorter than the frond; stipe and rachis densely covered with brown scales; frond elliptic-oblong in outline, eglandular, bipinnatifid; pinnae alternate, lance-linear, acuminate, short-petioled; pinnules with toothed margin, the teeth acute or obtuse but never setose, the lateral veins with 1 or 2 forks; sori about or below the middle of vein ramifications; indusium reniform, membranaceous, persistent; spores reniform-oval, crested and partly covered with truncate tubercles or warts. August, September.

Shady woods, in dry mold; in the north often associated with limestone and with stony or sandy soils. — European part: from Kar.-Lap. to Crimea and Caucasus; Caucasus: S., E. and W. Transc., Tal.; W. Siberia: Alt., E. Siberia: Yen.; Centr. Asia: Balkh., Dzu.-Tarb., Pam.-Al., T. Sh. **Gen. distr.:** nearly all Europe, Med., N. Am.

Economic importance. Used in medicine as tapeworm expellent; rhizome contains fatty and essential oils, resin, tannin, and filicinic acid ($C_{35}H_{42}O_{13}$). An export commodity.

Note. Known varieties: 1) var. *crenata* Milde, with approximate serrate or crenate-serrate pinnules; 2) var. *deorsolobata* Moore, with a long stipe and the biserrate lowest pinnules partly overlapping the rachis; 3) var. *affinis* (Fish. et Mey.) Newm., with sparse pubescence and biserrate pinnules; 4) var. *pseudorigida* Christ, with broad-petioled pinnules; 5) var. *athyriformis* Fom., with strongly dissected pinnules, resembling the leaves of *Athyrium filix femina* var. *multidentata*; and 6) var. *setosa* H. Christ, with the stout stipe and rachis profusely covered with rusty scales. In the Caucasus this species often hybridizes with *D. oreades* Fom.

7. ***D. sichotensis*** Kom. Bull. Jard. bot. Petr. XVI, I (1916) 146.

Perennial; rhizome unknown; leaves subcoriaceous, oblong, ca. 0.5 m long, 20–25 cm broad, green, bipinnate; rachis sparingly covered with narrow stramineous scales and hairs; pinnae oblong, 8–10 cm long, 3–6 cm broad, round-tipped; pinnules 1–3.5 cm long and 0.5–1 cm broad, decurrent at base, obtusely toothed or dissected; teeth short, bent toward the margin of the segment; veins concave; sori rather small; indusia small, reniform, brownish.

Coniferous woods. — Far East: Uss. (Ol'ga District). Described from Sikhote-Alin Range not far from Ternei Bay. Type in Leningrad.

8. ***D. oreades*** Fom. in Mon. Jard. bot. Tiflis 18 (1910) 20; in Fl. cauc. crit. I, 1, 47.

Perennial; leaves oblong-lanceolate to narrowly lanceolate, strongly narrowing toward base; stipe short, with pale brown scales; rachis covered with narrow lanceolate scales and hairs; pinnae sessile or subsessile, the upper linear-lanceolate and long-attenuate, the lowest oblong and obtuse; pinnules oblong, obtuse, approximate, with obtuse teeth and capillary scales; lateral veins of segments concave beneath, thickened at the ends and entering into the teeth; indusia coriaceous, light-colored, strongly vaulted; spores reniform, with warts and folds, occasionally winged.

Woods and scrub thickets of the subalpine zone. — Caucasus: Gr. Cauc., W. Transc. Described from the Greater Caucasus. Endemic. Type in Tiflis.

9. **D. barbellata** Fom. in Fl. Sib. et Or. Extr., V (1930) 59 cum ic.

38 Perennial; rhizome stout, oblique; leaves oblong-lanceolate, bipinnate, herbaceous; stipe short; stipe and rachis densely covered with brownish or stramineous narrowly lanceolate ciliate scales and hairs; upper and middle pinnae narrowly lanceolate to linear, more or less spreading; lower pinnae oblong-lanceolate; pinnules triangular-oval or oblong-linear, sessile, obtuse, the margin with obtuse teeth and scalelike hairs; lower pinnules almost dissected; veins not perucid, concave above; lateral veins widely forking; sori at the middle of segments; indusia subcoriaceous, brownish, vaulting; spores brownish. July, August. (Plate II, Figure 7 a—c).

Mountain woods. Far East: Uss., Sakh. Described from Khekhtsyr. Type in Leningrad.

10. **D. fragrans** (L.) Schott Gen. Fil. (1834) tab. 9; Kryl., Fl. Zap. Sib. 1, 23; Fom. in Fl. Sib. et Or. Extr. V, 61. — Polypodium fragrans L. sp. pl. (1753) 1089. — Nephrodium fragrans Rich. in Engl. Prantl I, 4, (1902) 173; Kom. in Fedde Repert. IX (1911) 394. — Polystichum fragrans Ldb. Fl. Ross. IV (1853) 514. — Aspidium fragrans Sw. Syn. Fil. 51. — Exs.: HFR, No. 2398.

Perennial; rhizome short, stout, oblique; leaves 15–20 cm long, linear-lanceolate, bipinnatifid, coriaceous, the upper surface, including rachis, covered with sessile glands, the lower surface chaffy with dark brown imbricated scales; stipe 1.5–2.5 cm long, densely covered with imbricated brown toothed and setaceous scales; pinnae subsessile, 1–2.5 cm long, the middle and upper oblong obtuse approximate, the lowest shorter than the others, oval, all fertile; pinnules oblong, obtuse, the margin erose-crenate; veins of segments thickened at the ends, with 1 or 2 forks; indusia reniform, membranaceous, persistent; spores elliptic, irregularly verrucose. July, August.

Placers and rocks. — Arc.: Arc. Sib., Chuk., An.; W. Siberia: Ob, (Sosva R. basin), Alt.; E. Siberia: Yen., Ang.-Say., Dau., Lena-Kol.; Far East: Kamch., Okh., Uda, Ze.-Bu., Uss., Sakh. Gen. distr.: Arctic belt of NW Am., Korea and N. Japan. Described from Transbaikalia. Type in Leningrad.

Economic importance. Owing to its coumarin content, the plant is aromatic and is used in perfumery and as a tea substitute. It is employed in Tibetan medicine.

Note. Variability is displayed in different regions. In the north the leaf segments are closely approximate and the sori are completely covered with glands and scales (var. *lepidota* Kom., 1911); in Ussuri forests the leaves are long, with narrower and somewhat distant segments, and sori are not lepidote or glandular (var. *remotiuscula* Kom., 1911).

11. **D. rigida** (Hoffm.) Und. Our Nat. Ferns, ed. IV (1893) 116. — Nephrodium rigidum Desv. Ann. Soc. Linn. Paris VI, 264. — Aspidium rigidum Sw. in Schrad. Journ., II (1800) 37. — Polypodium rigidum Hoffm. Deutschl. Fl. II. (1795) 6. — Ic.: Hook, Brit. Ferns tab. 16; Luer. Farnpfl. f. 147, 148. — Exs.: Wirtgen Pterid. exs., No. 283.

Perennial; rhizome stout, oblique; leaves narrow, oblong-lanceolate, rigid, 25–65 cm long, bipinnatisect, glandular on both sides; stipe densely beset with unicolor pale brown scales; pinnae lanceolate, pinnatifid; pinnules oblong, the lower ones short-petioled, pinnately lobate, the lobes

39 rounded-oval, their short teeth terminating in a short point; lateral veins of pinnules with 1 or 2 forks, the ends of ramifications more or less convergent; sori at the middle of vein ramifications; indusia membranaceous, glandular on all sides; spores oval-reniform, minutely verrucose. July-September.

Calcareous rocks of the alpine and subalpine zones. — Caucasus: Gr. Cauc., W. Transc. **Gen. distr.:** S. Scand., Centr. Eur. Described from Europe.

12. **D. Komarovi** Koss. in Notulae System. Herb. Hort. Petrop. II. I (1921) I.

Perennial; rhizome rather stout, erect; leaves light green, lanceolate to oblong-lanceolate, obtusish, 20–22 cm long, 7–8 cm broad; stipe 5–8 cm long, stramineous, covered with pale brown ovate or lanceolate acute scales and filiform trichomes interspersed with barely perceptible capitate hairs and narrow scales; pinnae 18 pairs, opposite or alternate, to 4 cm long and 1.8 cm broad, lanceolate to linear-lanceolate, obtuse; pinnules to 0.9 cm long and 0.6 cm broad, with 2 or 3 lobes on each side, their teeth terminating in a short thickish cusp; veins flexuous, with lateral forks; sori round; indusia small, thin. July.

Crevices of calcareous rocks. — Centr. Asia: Amu D., Pam.-Al., T. Sh. Endemic. Described from Khshartob on Yagnob River. Type in Leningrad.

13. **D. Raddeana** Fom. in Fl. Cauc. crit. I, 1 (1913) 57. — Nephrodium Raddeanum Fom. in Monit. Jard. Bot. Tiflis, XII (1908) 8. — Ic.: ib. tab. II et III.

Perennial; rhizome oblique; leaves long, coriaceous, naked or very sparsely glandular, oblong to oblong-deltoid, strongly tapering-attenuate toward apex, scarcely narrowing toward base; stipe two-fifths to one-half as long as the frond; stipe and rachis covered with oblong or lanceolate acute scales, these pale brown with a dark brown spot at center; pinnae lanceolate to narrowly lanceolate, tapering at apex into a long tail, short-petioled; pinnae oblong to oblong-lanceolate, obtusish, up to the middle of pinnae stalked, the margin lobed-dentate; teeth terminating in a short curved point; veins once or twice widely forking; sori at or slightly below the middle of vein ramifications; indusia naked or nearly so; spores reniform, brown, scarred-verrucose. July.

Woods. — Caucasus: Tal. Described from Azerbaijan. Endemic. Type in Tiflis.

14. **D. cristata** (L.) A. Gray Man. ed. I (1848) 631; Kryl., Fl. Zap. Sib. I, 24. — *Aspidium cristatum* Sw. in Schrad. Journ. II (1800) 37 et Syn. Fil. 52. — *Polypodium cristatum* L. Sp. pl. (1753) 1090. — *Polystichum cristatum* Roth Tent. Fl. Germ. III (1800) 84; Ldb. Fl. Ross. IV, 515. — Ic.: Engl. Bot. tab. 2125; Hooker brit. Ferns tab. 17; Luer. Farnpf. f. 152. — Exc.: Sredinsky Herb. crypt. Ross., No. 18 (sub *Aspidio*).

Perennial; rhizome oblique; leaves naked, to 1 m long; sterile leaves spreading, shorter, oblong; fertile leaves elongate-lanceolate, erect; all leaves bipinnate; lower pinnae pinnatisect, petioled, triangular-lanceolate or short-deltoid, cordate at base; pinnules oblong, obtuse, the margin

toothed, the tips of teeth setaceous; sori large, in 2 rows; indusia flat, naked; spores oval-reniform, with large tubercles and occasional small ridges. July-September.

Peat and forest bogs, alder groves, etc. — European part: from Kar.-Lap., Dv.-Pech., Lad.-Ilm. to the south as far as Bl. and upper part of L. Don; W. Siberia: Ob, U. Tob., Alt. **Gen. distr.:** Scand., Atl. Eur., Centr. Eur., Centr. Balkans, N. Am. Described from Europe. Type in London.

Note. Hybridizes with *D. spinulosa* (var. *uliginosa* auct.), e.g., in fir forests in N. part of the [former] Ural Region.

15. *D. spinulosa* (Müll.) O. Kuntze Rev. Gen. plant. II (1891) 813. — *D. euspinulosa* (Diels) Fom. in Fl. cauc. crit. I, 1 (1911) 59. — *Nephrodium euspinulosum* Diels in Engl. u. Prantl. 1, 4 (1902) 174. — *Polystichum spinulosum* Ldb. Fl. Ross. IV, 515, ex parte. — *D. spinulosa* subsp. *euspinulosa* Kryl., Fl. Zap. Sib. (1927) 26. — *Polypodium spinulosum* Müller Fl. Friedrichst. (1767) 193. — Ic.: Moore et Lindl. Brit. Ferns tab. 21. — Exs.: Sredinsky Herb. crypt. Ross. 1, No. 14; Baenitz Herb. Eur.

Perennial; rhizome stout, oblique; leaves light green, oblong-oval, nerveless, bipinnate, the long stipe and rachis clothed with unicolor light brown oval scales; pinnae short-attenuate; lowest pinnae subopposite, sometimes upturned in a narrow frond (var. *elevata* A. Br.), markedly distant from the rest, inequilateral, triangular-lanceolate, the others lanceolate; segments of pinnae oblong, pinnatifid, the lowest stalked, the upper confluent, all with softly setaceous teeth; lowest segments on the upper side (in the lowest pair of pinnae) larger than the rest; sori at the end of ramifications of lateral veins; spores minutely echinulous with occasional erose-winged ridges. July-August.

Mossy coniferous woods; often the most widespread fern in spruce forests. — European part: Dv.-Pech., Kar.-Lap., Lad.-Ilm., V.-Kama, U. and M. Dnp., V.-Don, Bl., L. Don; Caucasus: Cisc., Gr. Cauc., W. Transc.; W. Siberia: Ob, U. Tob., Alt.; E. Siberia: Yen. **Gen. distr.:** Scand., Atl. and Centr. Eur., mountains of Med., E. part of N. Am. Described from Europe.

- 41 16. *D. austriaca* (Jacq.) Woynar, Vierteljahr. Schr. Nat. Ges. Zür. LX (1919) 339. — *D. dilatata* Asa Gray Man. of Bot. U. S. A. (1848) 631. — *Nephrodium dilatatum* Desv. in Ann. Soc. Linn. Paris VI, 261. — *Polypodium austriacum* Jacq. Obs. I (1764) 45. — *D. spinulosa* subsp. *dilatata* Kryl., Fl. Zap. Sib. 1 (1927) 26. — *Polystichum spinulosum* Ldb. Fl. Ross. IV, 515 ex parte. — Ic.: Moore et Lindl. Brit. Ferns tab. 21–26. — Exs.: Sredinsky Herb. crypt. Ross. I, No. 15.

Perennial; rhizome stout, oblique; leaves 30 cm–1 m long, deltoid (var. *deltoidea* Milde), deltoid-oval to oblong-oval (var. *oblonga* Milde), tapering at apex, naked or more or less glandular; stipe shorter than frond, stramineous or rarely brownish; stipe and rachis chaffy with scales, these lanceolate or oblong-lanceolate, strongly acuminate, brown, mostly with a black stripe, rarely almost plain (var. *orientalis* Fom., Far East); pinnae approximate, with a narrow pinnatisect tip; segments of pinnae mostly pinnatifid, sometimes falcately pointed (var. *acuta* Fom.) and often covered beneath with numerous scales and glands (var. *lepidota*

Moore); lowest segments of the basal pair of pinnae on the upper side shorter than the next; lobes of segments often convex; ultimate (third order) segments sometimes remote (var. *remotiloba* Fom.) and obtuse, the tips with spreading teeth (var. *squarrosa* Fom.); teeth long, softly long-setaceous; indusia mostly glandular, the glands cylindric; veins of ultimate segments with 1 or 2 forks; sori at or above the middle of vein ramifications; spores reniform-oval, winged at margin, minutely echinulate on the sides. July, August.

Coniferous woods.—European part: Kar.-Lap., Lad.-Ilm., U. V., V.-Dnp.; W. Siberia: Ob.; E. Siberia: Yen., Ang.-Say., Dau.; Far East: Uss., Okh., Sakh., Kamch.; Caucasus: Cisc., W. Transc. **Gen. distr.:** nearly all Europe, incl. mountains of Med., N. Am. Described from Centr. Europe.

Economic importance. The rhizomes yield an extract with vermifuge properties.

Note. Hybrids occurring in the Caucasus are *D. austriaca* × *D. paleacea* and *D. austriaca* × *D. paleacea* f. *rubiginosa*, with stipe covered with rusty-black scales. In the north occurs the hybrid *D. austriaca* × *D. spinulosa*.

17. *D. Alexeenkoana* Fom. in Fl. cauc. crit. I, 1 (1911) 67.—*Nephrodium dilatatum* var. *pontica* Alexeenko in Herb.

Perennial; leaves to 1 m long, thin, with a powerful unpleasant odor, oblong-deltoid, acuminate, dark green, with scattered flask-shaped glands; petiole shorter than frond, lustrous in dry condition, dark castaneous, black in live condition; stipe and rachis glandular and covered with black, blackish-brown-margined scales and paleaceous black trichomes; pinnae in live condition inflated, lanceolate to triangular-lanceolate, acuminate, the lowest mostly fertile, oval-deltoid, inequilateral; segments of pinnae oblong-oval, acute; ultimate segments lance-linear, truncate, with toothed or dissected margin; teeth broadly oval, abruptly very long-setaceous; sori at or near the ends of vein ramifications; indusia scarious, glandular; spores oval-reniform, wingless and destitute of ridges. August, September.

Woods.—Caucasus: W. Transc. **Gen. distr.:** Endemic. Described from Abkhazia. Type in Tiflis.

D. laeta (Kom.) C. Christens. Index Filicum (1905) 273.—*Nephrodium laetum* Kom. Fl. Mandsh. 1 (1901) 124.

Perennial; rhizome stout, creeping; leaves oblong-oval, acuminate, twice or thrice pinnatifid; stipe canaliculate, stramineous, to 40 cm long, chaffy with light brown lance-linear acuminate scales; frond 30–50 cm long, rather rigid, green above, light green to subglaucous beneath; pinnae ascending at an acute angle, oblong-lanceolate in outline, acuminate; segments of pinnae lanceolate, acuminate, often lobed, toothed, terminating in a bristle-point; vein ramifications covered with pale brown capillary scales; sori in 2 rows at the middle of lateral veins; indusia with erose-dentate margin; spores coarsely tuberculate, cinnamon-colored.

Deciduous woods.—Far East (anticipated). Described from Manchuria, near Kirin. Type in Leningrad.

18. *D. wladivostokensis* B. Fedtsch. in AHP XXXI (1912) 99 sub *Nephrodium*.—*D. laeta* var. *wladivostokensis* Fom. in Fl. Sib. et Or. extr. V, (1930) 76.

Perennial; leaves broader than in the preceding, light green; segments of pinnae oblong-lanceolate, acute, pinnatifid, toothed at margin, the teeth terminating in a thick bristle-point; spores subreniform, verrucose, with broader ridges.

Mixed woods on slopes; rarely oak forests.— Far East: Uss.

Gen. distr.: Endemic. Described from the vicinity of Vladivostok (Okeanskaya station). Type in Leningrad.

19. **D. amurensis** Christ in Bull. Acad. intern. Geogr. Bot. 1909, 35, et in Mem. Acad. intern. Geogr. Bot. XX, 164.— *Aspidium spinulosum* Sw. var. *amurense* Milde Fil. Eur. et Atlant. (1867) 133.— Ic.: Fom. in Fl. Sib. et Or. Extr. V, 68.

43 Perennial; rhizome short, erect; rhizome and stipes covered with plain light brown oval pointed scales; leaves 1–3, deltoid-pentagonal, 3- or 4-pinnatifid, to 20 cm long, the stramineous stipe 30–40 cm long; lowest pinnae some 6.5 cm distant from the rest, semideltoid, inequilateral, acuminate; pinnules acuminate, their segments oval, subcordate at base, broad-stalked, 1.5 cm long, 0.5 cm broad, oblong, acuminate, the lowest dissected, the upper deeply lobed, the lobes serrate-toothed, the teeth setaceous; sori numerous, at the middle of segments; indusia naked; rachis sparingly covered with linear pale brown scales; underside of segments with inflated bladdery scales; spores elliptic-reniform, with anastomosing winged folds. July–September.

Coniferous woods on slopes.— Far East: Uss., Okh., Sakh. **Gen. distr.:** Hokkaido Island (Japan). Described from Sakhalin. Type in Paris.

20. **D. Linnaeana** C. Christens. Ind. Fil. (1905) 275.— *Nephrodium dryopteris* Michx. Fl. bor. Am. II (1803) 270.— *Phegopteris dryopteris* Fee Gen. Fil. (1850) 243; Shmal'g. II, 691.— *D. pulchella* (Salisb.) Hayek Fl. v. Steierm. (1906) 39; Kryl., Fl. Zap. Sib. 1, 28.— *Polypodium dryopteris* L. Sp. pl. (1753) 1093; Ldb. Fl. Ross. IV, 509.

Perennial; rhizome strongly branched, expanding over a large area; leaves horizontally spreading, naked, the slender petiole chaffy only at base; frond rather small, pentagonal, with 3 subequal long-petioled divisions, each division triangular and bipinnatifid, the lateral divisions asymmetric; pinnae sessile, oblong, obtusish, the lower pinnately divided with oblong toothed lobes, the middle pinnately divided, the upper entire, confluent at apex; veins of pinnules feathery, simple or once forking, or rarely veins pinnately forking and then the lower 2 or 3 segments of the third order disjunct (var. *disjuncta* Rupr. from Kamchatka); sori above the middle of vein ramifications; spores reniform, sparingly tuberculate, winged at the front and at the back. July–September.

Shady coniferous and deciduous woods.— European part: Kar.-Lap., Dv.-Pech. and southward down to Caucasus: Cisc., Dag., W. and S. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Ang.-Say.; Centr. Asia: Ar.-Casp. (Mugodzhary Mts.), Dzu.-Tarb. **Gen. distr.:** Atl. and Centr. Eur., Scand., Jap.-Ch., N. Am. Described from Europe. Type in London.

21. **D. continentalis** Petr. Fl. Jacut. 1 (1930) 15 cum ic., No. 12.

Perennial; rhizome long, slender; stipe long, slender; frond, as in the preceding species, with 3 divisions, but the terminal division slightly longer

than the lateral; upper part of stipe and the rachis covered with yellowish glands; indusia wanting; spores as in the preceding. August.

Shady coniferous woods, among mossy undergrowth.— E. Siberia: Lena-Kol. Described from Olensk and Lena rivers. Type in Leningrad.

- 14 22. **D. Robertiana** (Hoffm.) C. Christens. Ind. Fil. (1905) 289; Kryl., Fl. Zap. Sib. 1, 28.— *Nephrodium Robertianum* Prantl Excurs. Fl. Kgr. Bayern (1884) 24.— *Phegopteris Robertiana* A. Br. in Aschers. Fl. Brand. (1864) 198; Shmal'g, II, 691.— *Phegopteris calcarea* Fée Gen. Fil. (1850) 243.— *Polypodium Robertianum* Hoffm. Deutschl. Fl. II (1795) 20.— *Polypodium dryopteris* var. *Robertianum* Ldb. Fl. Ross. IV, 509.— Ic.: Luer. Farnpfl. fig. 134; Fom. in Fl. Sib. et Or. Extr. 81.— Exs.: HFR, No. 1150, 1150a.

Perennial; rhizome shorter, creeping; leaves erect, bipinnatifid, deltoid, with 3 divisions, the terminal much longer than the lateral; stipe slender, 30–45 cm long; pinnae pinnately divided, their segments oblong, obtuse, crenate, the veins simple or once forking; stipe and the underside of the frond covered with short glandular hairs; sori above the middle of vein ramifications, sometimes confluent; spores suboval, winged, with anastomosing folds. July, August.

Calcareous rocks in woods.— European part: Lad.-Ilm., V.-Kama, U. V., Crim.; Caucasus: Dag., Gr. Cauc., S. Transc.; W. Siberia: Ob (Tomsk, Tobol'sk), Alt.; E. Siberia: Ang.-Say., Dau.; Far East: Uss., Okh. **Gen. distr.**: Atl. and Centr. Eur., N. Am. Described from Germany.

23. **D. phegopteris** (L.) C. Christens. Ind. Fil. (1905) 284.— *Nephrodium phegopteris* Baumg. ex Diels in Engl. u. Prantl 1, 4 (1900) 170.— *Phegopteris polypodioides* Fée Gen. Fil. (1850) 243; Shmal'g, II, 692.— *Polypodium phegopteris* L. Sp. pl. (1753) 1089; Ldb. Fl. Ross. IV, 508.— Ic.: Fedch. and Fl., Opred. rast. Sib., Figure 10.— Exs.: HFR, No. 550; Sredinsky Herb. crypt. Ross., 1; No. 9 et 9b.

Perennial; rhizome slender, creeping; stipe longer than frond, sagittate-deltoid, long-tapering at apex, hairy on both sides; pinnae oblong-lanceolate or often linear-lanceolate, strongly acuminate, deeply bipinnatifid, with oblong, obtuse crenulate lobes; lowest lobes of upper segments confluent and decurrent on the rachis; lowest pair of segments remote and projected downward; veins of lobes simple or once forking; sori at the ends of vein ramifications; spores reniform, with narrow ridges. July, August.

Deciduous and shady coniferous woods.— European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., V.-Kama, U. Dnp., M. Dnp., V.-Don, Bes.; Caucasus: Cisc., W. Transc.; W. Siberia: Ob (Tobol'sk and Tomsk), Alt.; E. Siberia: Ang.-Say.; Far East: Kamch., Okh., Uss., Sakh. **Gen. distr.**: Atl. and Centr. Eur., Med., N. Am. Described from Europe. Type in London.

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Genus 8. **POLYSTICHUM*** ROTH.

in Rom. Arch. 2 (1799) 106; Tent. Fl. Germ. (1800) 69.

Sori round, at the middle or end of vein ramifications; indusia round, attached by the middle; nonfertile veins never thickened; stipe not jointed; leaves coriaceous, stiffly bristle-tipped; spores bilateral.

* From Greek poly, many, and stichos, row, the sori being arranged on the leaves in several ranks.

1. Leaves narrowly lanceolate, linear-lanceolate or tripartite, pinnatifid . . . 2.
- + Leaves oblong, oval-oblong, bipinnate or tripinnate 4.
2. Leaves with 3 unequal divisions; segments elongated, hatchet-shaped, toothed, the upper margin auriculate at base; central division 2—3 times as long as the lateral 2. **P. tripterum** (Kunze) Presl.
- + Leaves not tripartite. 3.
3. Leaves coriaceous, narrowly-lanceolate; segments rather small, hatchet-shaped, with a small auricle at the base of the upper margin; rachis often prolonged into a bud capable of rooting 3. **P. craspedosorum** (Maxim.) Diels.
- + Leaves stiffly coriaceous, rather large; lowest segments triangular, with a short auricle at the base of the upper margin; other segments broadly cordate, with a large auricle; all segments serrate-aristate 1. **P. lonchitis** (L.) Roth.
4. Leaves deltoid to triangular-deltoid; rachis covered with castaneous capillary scales; rachis with lanceolate black-centered scales 4. **P. Woronowi** Fom.
- + Leaves narrowing toward base 5.
5. Leaves softly coriaceous; segments of pinnae numerous, small, obtusely auriculate at base, abruptly aristate. 5. **P. angulare** (Presl.) Fom.
- + Plants with different characteristics 6.
6. Leaves coriaceous, wintering 7.
- + Leaves soft, not wintering, segments of pinnae larger than in the preceding species, broader, shortly auriculate at base, obtuse, softly aristate 7. **P. Braunii** Fée.
7. Pinnae lanceolate, acuminate; segments oblong-lanceolate, acute, often acutely auriculate at base, their veins narrowly forking; sori often confluent 6. **P. lobatum** Sm. Presl.
- + Pinnae long-tapering; segments oblong-lanceolate or subfalcate, acute, auriculate at base, coarsely and sharply incised-serrate, strongly projected forward; veins more widely forking; sori not confluent **P. microchlamys** Kodama.

1. **P. lonchitis** (L.) Roth in Roem. Mag. 2 (1799) 106; Kryn., Fl. Zap. Sib. 1, 30.—*Aspidium lonchitis* Sw. in Schrad. Journ. d. Bot. 11 (1800) 30; Ldb. Fl. Ross. IV, 512.—*Polypodium lonchitis* L. Sp. pl. (1753) 1088.—Ic.: Fedch. and Fl., Opred. rast. Sib., Figure 18; Luerss. Farnpfl. 324, f. 137.—Exs.: Sredinsky. Herb. crypt. Ross., No. 17; Herb. Fl. Asiae Med., No. 402.

Perennial; rhizome short, stout; leaves coriaceous, lanceolate, pinnatifid; stipe 2—7 cm long; frond 6—10 times the length of stipe, the lower surface sparsely chaffy, the rachis more closely covered with broader scales; segments approximate, the lower short-triangular, the middle and upper broadly lance-falcate, acutely auricled at the upper margin, the auricle sometimes strongly developed (var. *hastatum* Christ.), the margin doubly serrate; teeth aristate, the awn sometimes long (var. *longearistatum* Christ.); veins of segments twice or thrice forking; sori between the midvein and the margin, at the middle of vein ramifications, arranged in a single rank; indusia peltate, membranaceous, toothed at the margin; spores reniform-oval, with simple sharp 2-toothed spinules. July, August.

Shaded or exposed rocks in the forest and alpine zones.— European part: Kar.-Lap., V.-Kama (Centr. Urals), Crim.; Caucasus: Gr. Cauc., Dag., mountains of Lesser Caucasus; W. Siberia: Ob (Tobol'sk and Tomsk), Alt.; E. Siberia: Ang.-Say.; Far East: Kamch., Sakh.; Centr. Asia: Dzu., T. Sh. **Gen. distr.**: mountains of Centr. and S. Eur., N. Am. (in Greenland to 69°N. lat.). Described from the alpine zone of Switzerland. Type in London.

2. **P. tripterum** (Kunze) Presl. Epim. (1849) 55.— *Aspidium tripterum* Kunze Bot. Ztg. (1848) 569.— Ic.: Diels in Engl. u. Prantl 1, 4 (1902) 190, f. 90; Kom. and Alis., Opred. (1931), Plate 8.

Perennial; rhizome short; leaves 3-parted, the terminal division exceeding the lateral; frond subcoriaceous, paripinnate, the long petiole and the rachis covered with brown scales; segments narrowly lanceolate and subfalcate, auricled at the upper margin, acutely twice-serrate, ca. 4 cm long and 1.5 cm broad, cuneate at base; sori marginal; indusia small; spores elliptic, with a plaited coat. July-September.

Mixed woods.— Far East: Uss. **Gen. distr.**: Jap.-Ch. Described from Japan. Type in Leningrad.

47 3. **P. craspedosorum*** (Maxim.) Diels in Engl. u. Prantl 1, 4 (1902) 189.— *Aspidium craspedosorum* Maxim. in Bull. Acad. Petr. XV (1871) 231.— Ic.: Diels, l. c.; H. Christ Farnkr. d. Erde (1897) 235, f. 743; Kom. and Alis., Opred. (1931), Plate 19.

Perennial; rhizome short; leaves to 15 cm long and 5 cm broad; stipe short, densely chaffy; frond linear-lanceolate, coriaceous, pinnatipartite, the rachis prolonged into a bud capable of rooting; segments hatchet-shaped, auricled at the upper margin, 2 cm long, 1 cm broad; margin of segments crenate-dentate; sori largely confined to the upper margin, large, with persistent indusia; spores elliptic, with a granular surface. August, September. (Plate I, Figure 7 a-c).

Shaded rocks, preferably limestone.— Far East: Uss. Described from Sikhote-Alin. Type in Leningrad.

Note. Suitable for greenhouse culture to demonstrate tip-rooting ferns.

4. **P. Woronowi** Fom. in Moniteur du Jard. bot. d. Tiflis, 18 (1910) 21; in Fl. cauc. crit. I, 1, 94.— Ic.: Fom. (1900) tab. ad p. 22.

Perennial; leaves oblong-deltoid, acuminate, subcoriaceous-membranaceous, dull dark green above; pinnae lance-linear, the upper ones projected falcately upward, the middle ones horizontal; pinnules 8-12 mm long, 4-5 mm broad, oval to oblong-oval, serrate-lobed or incised-lobed, obtuse, abruptly aristate at apex, with an oval auricle at base, the lobes toothed-aristate; lateral veins of sterile segments narrowly forking, those of fertile segments more widely; sori at the ends of vein ramifications; indusia dark castaneous; spores brown, reniform-oval, with toothed ridges; stipe chaffy with dark castaneous black-centered scales; rachis with capillary dark castaneous scales. July, August. Spores often wanting.

Beech and other shady woods.— Caucasus: W. Transc., Tal. **Gen. distr.**: Endemic. Described from Abkhazia. Type in Tiflis.

* From Greek *craspedon*, margin or border, and *sorus*, heap, bundle, referring to the marginate sori.

5. *P. angulare* (Presl.) Fom. emend. in Fl. cauc. crit. I, 1 (1911) 89.— Ic.: Moore et Lindl. Brit. Ferns tab. 12; Luer. Farnpf. f. 139.— Exs.: Herb. H. Christ., Hispan., Galicia.

Perennial; rhizome stout, densely chaffy; leaves oblong or oblong-lanceolate, relatively soft, bi- or tripinnate; pinnae lanceolate, acuminate; pinnules to 8 mm long and 4 mm broad, with slender stalks, oval, obtusely auricled at base, sometimes conspicuously auricled (var. *hastulatum* Knze.), obtuse at apex, long-awned, the lobes often small (var. *microlobum* Warnst.), the sinuses between the lobes and between the
48 pinnules rounded; lowest pinnules coarsely incised but equaling the others; lateral veins with 1 or 2 open forks; sori at the end of vein ramifications; indusia thin, scarious; spores oval, with entire-margined ridges, wrinkled on the sides; stipes chaffy with large scales interspersed with capillary brown scales, these spreading over to the rachis. July, August.

Shady beech woods.— European part: Crim.; Caucasus: W. Transc. **Gen. distr.:** Centr. Eur., Med. Described from Central Europe. Type in London.

Note. Hybridizing in the Caucasus with *P. lobatum* Presl. and *P. Braunii* Fée.

Economic importance. An ornamental plant for rockeries.

6. *P. lobatum* (Sw.) Presl Tent. Pterid. (1836) 83 emend.— *Aspidium lobatum* Sw. in Schrad. Journ. II (1800) 37; Shmal'g. II, 693.— Ic.: Moore et Lindl. Brit. Ferns tab. 10 et 11; Luer. Farnpf. 335, f. 138.— Exs.: Sredinsky Herb. crypt., No. 13; Herb. Fl. Asiae med., No. 401.

Perennial; leaves hard, coriaceous, perennial, somewhat lustrous, lanceolate, acuminate, bipinnate; pinnae oblong-lanceolate to lanceolate, sometimes narrow and crenate (var. *angustilobum* Fom.), gradually tapering; pinnules sessile or the lowest short-petioled, elliptic, acuminate, projected forward, the lowest large, sometimes conspicuously so (var. *umbraticum* Knze.), acutely auricled at base, all serrate with stiff bristles; auricles sometimes strongly drawn out (var. *auriculatum* Luer.) and bristles elongated (var. *aristatum* Christ.); lower leaf surface covered with narrow capillary scales; stipes and rachis chaffy with large brown scales; sori few, large, confluent, borne above the middle of vein ramifications; indusia membranaceous; spores oval, with anastomosing ridges. July, August.

Deciduous woods and rocks, also in the alpine zone.— European part: M. Dnp. (Volhynia), L. Don (Kharkov area, Pokotilovka); Caucasus: Cisc. (Stavropol), Dag., E. and W. Transc., Tal.; Centr. Asia: T. Sh. (Chatkal), Pam.-Al. (Gissar, Khakimi). **Gen. distr.:** Centr. Eur., Med., Bal.-As. Min. Described from Central Europe. Type in London.

7. *P. Braunii* Fée Gen. Fil. (1850), 282; Kryl., Fl. Zap. Sib. I, 31; *Aspidium Braunii* Fl. Freib. 1, 9 (1825); Shmal'g. II, 692.— Ic.: Spenn, l. c., f. 94—96; Luer. Farnpf., 352, f. 141, 142.— Exs.: Fl. exs. Austro-Hung., No. 2035.

Perennial; leaves membranaceous, oblong-lanceolate, lustrous when alive, bipinnatifid, the rachis and veins covered with chaffy trichomes; pinnae horizontal, oblong, the lower obtuse, the upper short-acuminate; pinnules at a right angle to midrib of pinna, oblong-trapezoid, obtusely

49 auricled at base, the midvein flexuous and sometimes perlucid, the lateral veins once or twice forking; sori rather large, confluent, borne at or near the ends of vein ramifications; spores oval-reniform, with anastomosing and irregularly toothed ridges, the surface of the ridges minutely echinulate throughout. July, August.

Shady woods.— European part: U. V., M. Dnp.; Caucasus: Cisc., W. and E. Transc.; W. Siberia: Ob (Tomsk), Alt.; E. Siberia: Yen.; Far East: Uss., Sakh. **Gen. distr.:** Scand., Atl. and Centr. Eur., Jap.-Ch., N. Am. Described from Europe.

8. **P. microchlamys** Kodama in Tokyo Bot. Mag. XXIX (1925) 326.— *P. kamtschaticum* C. Christens et E. Hulten ex Fom. in Fl. Sib. et Or. Extr. V (1930) 94.— *P. Braunii* var. *kamtschaticum* C. Christens et E. Hult. in Hulten. Fl. Kamtsh. 1 (1927), 38.— *P. Braunii* var. *subsessilis* Kom. Fl. Kamtsch. (1927) 64.— Ic.: E. Hulten. Fl. of Kamtsch. I, tab. 2.

Perennial; leaves oblong-lanceolate, coriaceous, acute, dark green, bipinnatifid, to 1 m long and to 25 cm broad; pinnae lanceolate, long-tapering toward apex; pinnules oblong-lanceolate to lanceolate, acute, sharply serrate, often subfalcate, the lower auriculate, the sharp teeth aristate; stipes rather long, densely chaffy with narrow lanceolate and linear scales; sori in 2 ranks, not confluent; spores elliptic, irregularly plicate-rugose; indusia persistent. August,

Shady gullies and glades among alder thickets.— Far East: Kamch. **Gen. distr.:** N. Japan, Kurile. Described from Japan. Type in Geneva.

Subfamily 3. **Davalliaceae** Diels.

Genus 9. **MICROLEPIA** * PRESL.

Presl. Tent. Pterid. (1836) emend.; Prantl in Arbeiten Bot. Garten Breslau 1, 25.

Sori terminal, close to leaf margin; indusium attached at the base as well as the sides of the outer segment lobe, cup-shaped; sori distinctly stalked; rhizome creeping; leaves in two ranks; stipes not jointed, destitute of scales and chaff.

- 1. Plant almost glabrous; pinnae inequilateral, deltoid, the outer margin truncate; spores warty. 1. **M. Wilfordii** Moore.
- + Plant covered with articulate hairs; lower pinnae deltoid-lanceolate, the middle and upper narrowly lanceolate to linear-lanceolate; spores smooth. 2. **M. pilosella** (Hook.) Moore.

50 1. **M. Wilfordii** Moore Ind. Fil. (1861) 299.— *Davallia Wilfordii* Baker in Hook. Syn. Filicum (1874) 88.— *D. rhomboidea* Hook. Second Cent. (1861) tab. 48.— Ic.: Hook., l. c., tab. 48; Fedch. and Fl., Oprel. rast. Sib., Figure 22.— Exs.: HFR No. 2399.

Perennial; rhizome creeping, black; leaves narrowly lanceolate, not narrowed toward base, bipinnatifid or sometimes almost tripinnatifid, to 30 cm long and 4.5 cm broad; stipe brown at base, about as long as the frond; lower pinnae commonly sterile, obtusely deltoid, apparently truncate

* From Greek micros, small, and lepis, scale, alluding to the small size of indusium.

at base on the outer side; sterile pinnae acutely deltoid, pinnately parted; pinnules narrowly oblong; veins of segments almost fan-shaped, some entering the lobes and bearing the sori; sori 4–8 per segment, marginal; spores tetrahedral, warty. July–September.

Damp rocks and stony stream beds, chiefly on limestone among mixed woods.— Far East: Uss. **Gen. distr.:** Jap. -Ch. Described from Japan. Type in London.

2. **M. pilosella** Moore Ind. Fil. (1861) 298.— *Davallia pilosella* Hook. Second Cent. Ferns (1861) tab. 96.— *Trichomanes hirsutum* Thunb. Fl. Jap. (1784) 339, non L.— *Davallia hirsuta* Hook. Syn. Fil. (1868) 98.— *Microlepia hirsuta* Sw. Syn. Filic. (1806) 131 et 343.

Perennial; rhizome slender, creeping, branched; leaves oblong-lanceolate, to 30 cm long and 6 cm broad, bipinnatipartite; lowest pinnae deltoid-lanceolate, the middle and upper lanceolate; pinnules oval, incised-dentate, covered on both sides with articulate hairs; stipe about half as long as the frond; sori 5 or 6 per segment, at the margin of teeth; spores tetrahedral, smooth. July–September.

Damp stony places and rocks among shrubs.— Far East: Uss. **Gen. distr.:** Jap. -Ch. Described from Japan. Type in Uppsala.

Subfamily 4. **Aspleniceae** Dieß

Sori and indusia borne along the veins, elongate or linear, attached only at one side.

Key to Genera

- 1. Fertile and sterile leaves alike 2.
- + Fertile leaves differing in shape, their segments very much narrowed 16. **Blechnum** L.
- 2. Leaves simple, entire 3.
- + Leaves bipinnate or tripinnate 5.
- 3. Leaves small, linear-lanceolate or broadly lanceolate, prolonged into long rooting tips 12. **Camptosorus** Link.
- + Leaves larger, not rooting at tips 4.
- 4. Leaves cordate at base, linear-lanceolate or lorate, acuminate, glabrous, cordate at base 11. **Phyllitis** Ludwig.
- + Leaves oblong-lanceolate or lanceolate, with rounded alternate segments, glabrous above, covered beneath with light brown ovate scales 15. **Ceterach** Willd.
- 5. Leaves 30 cm to 1 m long, bi- or tripinnate; sori oval to linear, hooked or horseshoe-shaped; indusia the shape of sori or sometimes obsolete 10. **Athyrium** Roth.
- + Leaves 3 to 30 cm long 6.
- 6. Rhizome creeping, very slender; leaves 3–5 cm long, 1.5–2 cm broad, oblong, bipinnatisect, hairy; sori borne along the veins 14. **Pleurosoriopsis** Fom.

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- + Rhizome short; leaves pinnate or bi- or tripinnatifid; sori borne beside the veins, mostly on the inner side, linear . . . 13. **Asplenium** L.

Genus 10. **ATHYRIUM** ROTH.

Roth, in Romer Arch. Bot. 2 (1799) 105.

Sori unilateral, oblong, often hooked or horseshoe-shaped, very rarely round, curving above the veinlet; indusia oblong or hook-shaped or horseshoe-shaped; scales consisting of loose thin-walled cells; stipes not jointed, with two vascular bundles at base, these horseshoe-shaped in cross section above.

1. Leaves triangular in outline 11.
- + Leaves oblong or oblong-deltoid 2.
2. Pinnules obtuse 3.
- + Pinnules more or less pointed 4.
3. Pinnules oval-rhomboid, obtuse, crenulate, inequilateral, auriculate at base; sori in a row on each side of the midrib 10. **A. Wardii** (Hook.) Makino.
- + Pinnules oblong-linear, obtuse, approximate, slightly denticulate; sori straight, nearly as long as the veinlet, oblique in relation to midrib 1. **A. acrostichoides** (Sw.) Diels.
4. Indusia obsolescent or wanting 5.
- + Indusia well developed 6.
5. Leaves always tripinnatifid; pinnules oval-oblong; ultimate segments oblong to oblong-linear, crenate-dentate; sori subovate; spores plicate-rugose 7. **A. austro-ussuriense** (Kom.) Fom.
- + Leaves bipinnatifid; ultimate segments oblong, with scattered obtuse teeth; outer coat of spores rugose-plicate 6. **A. alpestre** (Hoppe) Rylands.
6. Indusia fringed or toothed 7.
- + Indusia entire 9.
7. Stipe and leaf rachis wine-red; rachis and principal veins densely clothed with glandular bloom 3. **A. rubripes** Kom.
- + Stipe not red, destitute of bloom 8.
8. Leaves subcoriaceous; sori linear or oblong, slightly curved; indusia slightly curved, oblong-linear; spores minutely echinulate 4. **A. monomachi** Kom.
- + Leaves soft, membranaceous; sori oblong or reniform; spores finely granular 2. **A. filix femina** (L.) Roth.
9. Indusia oblong; pinnules sessile, decurrent and hence the rachis broadly zigzag-winged; sori in a row on each side of the midrib 5. **A. pterorachis** H. Christ.
- + Indusia hooked or horseshoe-shaped 10.
10. Pinnules oblong, acute, sessile or very narrowly cuneate-based, regularly incised-dentate; sori varying from hook-shaped to horseshoe-shaped, rarely sublinear 8. **A. yokoscense** (Fr. et Sv.) H. Christ.
- + Pinnules very acute, oblong, cuneate at base, inequilateral, coarsely and acutely incised-dentate, the teeth apparently with an elongated auricle at base; sori horseshoe-shaped 9. **A. Göringianum** (Knze) Moore.

* From a, negation, and thyreos, shield, implying that the indusium is not shield-shaped.

11. Leaves relatively larger, triangular, tripinnatifid, crenate; stipe with shining black chaff at base 11. *A. crenatum* (Sommerf.) Rupr.
 + Leaves relatively smaller, triangular, tripinnatifid, the ultimate segments sharply toothed; stipe with brownish-yellow chaff 12. *A. spinulosum* (Maxim.) Milde.

1. *A. acrostichoides* (Sw.) Diels in Engler u. Prantl. 1, 4 (1903) 223. — *A. thelypteroides* Desv. Mem. Soc. Linn. Paris 6 (1827) 266. — *Asplenium thelypteroides* Michx. Fl. bor. Am. II (1803) 265. — *Asplenium acrostichoides* Sw. in Schrad. Journ. (1800) 54. — Ic. Fom. in Fl. Sib. et Or. extr. V, 105.

Perennial; rhizome oblique, stout, 25–55 cm long; stipe ca. 25 cm long; stipe and rachis covered with short and very narrow scales; frond membranaceous, glabrous, oblong-lanceolate, bipinnatifid; pinnae approximate, linear-lanceolate, sessile, to 10–12 cm long and 3 cm broad; pinnules linear, almost entire, round-tipped; venation feathery; sori oblong, straight; indusia inflated, entire; spores reniform-oval, plicate-rugose. July, August. (Plate II, Figure 2 a–c).

Mossy soil in dense mixed and coniferous forests. — Far East: Uss.
Gen. distr.: Jap. -Ch., N. Am. Described from North America.

2. *A. filix femina* (L.) Roth. Tent. Fl. Germ. III (1800) 65; Kryl. Fl. Zap. Sib. 1, 33. — *Polypodium* f. f. L. Sp. pl. (1753) 1090. — *Asplenium filix femina* Bernh. in Schrad. Journ. 1, 2 (1806) 26; Ldb. Fl. Ross. IV, 513; Shmal'g. II, 688. — Ic.: Moore et Lindl. Brit. Ferns tab. 30–34; Luer. Farnpl. f. 92–101. — Exs.: Wirtgen Pterid. exs., No. 110d, 176b, 108c, 108d.

Perennial; rhizome stout, oblique; leaves elongated, large, softly membranaceous; stipe more or less chaffy, sometimes stramineous and covered with stiff black scales and prolonged into a black rachis (var. *nigro-paleaceum* Makino, Sakhalin), the rachis sometimes covered with pale glandular hairs (var. *pruinatum* Moore); frond elliptic-oblong, acuminate, twice or thrice pinnatifid; pinnae multijugous, acuminate; pinnules lanceolate, acute, narrow, subfalcate, sometimes sharply tail-pointed (var. *acuminatum* Fom.), divided into oblong-linear segments, the margin dentate or even bi- or tridentate (var. *fissidens* Döll.), the segments sometimes petioled (var. *tenuilobum* Fom.); lateral veins of pinnules once or twice forking, those of well developed and sometimes linear-oblong ultimate segments (var. *multidentatum* Döll.) simple; sori oblique, ovate or lunate, rarely round (var. *cyclosorum* Rupr.), sometimes hook-shaped, in well developed ultimate segments in a row on each side of the veinlet (var. *tripinnatum* Rupr.) or more often in a single row; indusia with fringed margin; spores ovate-reniform, brown, minutely granular or if finely rugose then sori reniform and pinnules stiff (var. *lastraeiformis* Fom.). June, August. (Plate II, Figure 1 a–L).

Woods of all types, thickets, riverside brushwood, gullies, etc. — Arc.: Anad.; European part: from Kar.-Lap. and Dv.-Pech. down to the steppe region; Caucasus: Cisc., Dag., W., E. and S. Transc., Tal.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Ang.-Say., Dau.; Far East: Ze.-Bu., Uss., Okh., Kamch., Sakh. **Gen. distr.:** Scand. and Centr. Eur.,



Plate II

1. *Athyrium filix femina* Roth.: a) leaf segments with sori beneath; b) underside of pinnule; c) and d) cross section of stipe below and at the frond base.—2. *A. acrostichoides* Diels.: a) pinna; b) pinnule with sori; c) spores.—3. *A. pterorachis* Christ.: a) upper surface of one of the shorter pinnae; b) underside of pinnule; c) spores.—4. *A. alpestre* Rylands: a) underside of pinna; b) underside of pinnule; c) spores.—5. *A. yokoscense* Christ.: a) underside of pinnule.—6. *A. spinulosum* Milde: a) general aspect; b) ultimate segment beneath; c) spores.—7. *Dryopteris barbellata* Fom.: a) underside of pinnule; b) underside of an ultimate segment; c) scales.—8. *Cryptogramma acrostichoides* R.Br.: a) general aspect; b) portion of sterile leaf; c) spores.

Bal. -As. Min., Ind. -Him., Jap. -Ch., N. Am. Described from Europe. Type in London.

Economic importance. A rootstock infusion is used in medicine as vermifuge. An ornamental plant of horticultural value.

3. **A. rubripes** Kom. in Bull. du Jard. Bot. de Kieff, XIII (1931) 145.— *A. filix femina* var. *rubripes* Kom. in Bull. Jard. Bot. Petr. XVI (1916) 149.

Perennial; rhizome stout, oblique; stipes channeled, wine-red, 12 cm long, covered with plain pale narrow scales; leaves up to 1 m, as broad as long, bi- or tripinnate; pinnae reddish-green when alive, the veins protruding beneath, the sharp teeth contiguous; sori elliptic or linear, rather small, ca. 1 mm long; indusia brown, often angular; spores reniform, minutely verrucose. July, August.

Mixed woods on mountain slopes.— Far East: Uss. **Gen. distr. :** Endemic. Described from Suputinka River. Type in Leningrad.

4. **A. monomachi*** Kom. in Bull. du Jardin Bot. de Kieff, XIII (1931) 145.— *A. filix femina* var. *monomachi* Kom. in Bull. Jard. Bot. Petr., XVI (1916) 149.

57 Perennial; rhizome stout, oblique; stipes ca. 25 cm long, channeled, stramineous, densely covered at base with narrow long-pointed brown scales; leaves bipinnate, stiffish, lustrous above, naked except for rachis; pinnae subopposite, very sparsely glandular; pinnules oblong, acute, rather rigid, 15–20 mm long, 5–8 mm broad, incised-pinnate; teeth contiguous, sharp, often bifid, curved or straight; sori sublinear, rarely somewhat curved; indusia with fringed margin; spores reniform, very minutely verrucose-echinulate. July.

Mixed woods and thickets.— Far East: Uss. Described from Tyutikhe River. Type in Leningrad.

5. **A. pterorachis** H. Christ. in Bull. Herb. Boiss. IV (1896) 668.— Ic. : Fom. in Fl. Sib. et Or. Extr. V (1930) 120.

Perennial; rhizome stout, oblique; leaves to 1 m long, oblong-oval, ca. 40 cm broad, naked above; scales on rachis partly slender, partly broad, ovate, to 1 cm long; frond bipinnate; pinnae lanceolate, strongly tapering to a point, up to 20 cm long, at the base of frond abbreviated; pinnules sessile, linear-lanceolate, uniformly lobed along the margin, strongly dilated and confluent at base; ultimate segments triangular-ovate, often forming long reflexed teeth; all pinnules confluent and the rachis winged; veins pinnately branched, often forked; sori oval, sometimes hook-shaped, in a single row, close to midrib; indusia membranous, entire, brown; spores ovate, plicate-rugose. July, August. (Plate II, Figure 3 a–c).

Woods and thickets.— Far East: Sakh., Kamch. Described from Sakhalin. Type in Leningrad.

6. **A. alpestre** (Hoppe) Rylands in Moore Ferns of Gr. Br. and Ir. Nat. pr. (1857) VII, 224; Kryl., Fl. Zap. Sib. I, 34.— *A. rhaeticum* Roth. Fl. Germ. (1800), III, 67.— *Aspidium alpestre* Hoppe Taschenb. (1805), 216.— Ic. : Moore et Lindl. Brit. Ferns tab. 7; Fom. in Fl. Sib. et Or. Extr. 117.— Exs. : Wirtgen Pterid. exs., No. 390, 51.

* Name derived from locality where this fern was first found.

Perennial; rhizome rather stout, erect, covered as the stipes with scales, these brown with a black median stripe; leaves soft, dark green, oblong-lanceolate to oblong, bi- or tripinnatifid; pinnae lanceolate, strongly acuminate; pinnules oblong-lanceolate, often pointed, incised-lobed, with dentate-crenate segments; ultimate segments of more developed leaves oblong, obtuse, often rounded, dentate-crenate; veins once or more widely forking; sori close to incisions of the segments; sori on ultimate segments often in two rows and close to margin; indusia wanting; spores ovate, brown, rugose-plicate. August, September. (Plate II, Figure 4 a—c).

Subarctic zone and mountain woods near the timberline, alpine scrub zone, and occasionally alpine meadows. — European part: Kar. -Lap., Dv. -Pech. (N. Urals); Caucasus: Gr. Cauc.; W. Siberia: Ob, Alt.; E. Siberia: Yen., Ang. -Say.; Far East: Kamch. **Gen. distr.:** Scand., mountains of N. Eur., Atl. Eur. (Scotland), Iceland, N. Am. Described from Germany.

7. **A. austro-ussuriense** (Kom.) Fom. in Fl. Sib. et Or. Extr. V (1930) 122. — *Dryopteris austro-ussuriensis* Kom. in Bull. Jard. Bot. Petr. XVI (1916) 147. — *Phegopteris austro-ussuriensis* Kom. in Kom. and Al., Opred. 1 (1925) 65. — Ic. Fom., l. c., 123.

Perennial; rhizome branched, creeping, densely chaffy at the top, rather slender; stipes solitary, 40–60 cm long, 5 mm thick, at base black, inflated, sparsely covered with narrow scales; leaves tripinnatifid, large, 30–70 cm long and 20–60 cm broad, broadly ovate, dull green, the rachis covered with short articulate white hairs and scattered narrow pointed scales; pinnules 10 cm long, 4–10 cm broad, oblong, slender-pointed; ultimate segments approximate, 5 mm long, 2–3 mm broad, obtusely round-tipped, with short appressed sharp teeth; veins of ultimate segments often simple, partly forking, brownish, translucent; indusia wanting; sori round or oblong, in two rows on the sides of midrib; spores reniform-oval, plicate-rugose. July, August.

Shady mixed woods, at the foot of slopes. — Far East: Uss. **Gen. distr.:** Korea, Manchuria. Described from Suputinka River. Type in Leningrad.

8. **A. yokoscense** (Fr. et Sav.) H. Christ. in Bull. Herb. Boiss. IV (1896) 668. — *A. nipponicum* Kom. Fl. Mansh. 1 (1902) 134 (non Diels). — *Asplenium yokoscense* Fr. et Sav. Enum. pl. Jap. II (1879) 622. — Ic. Fom. in Fl. Sib. et Or. Extr. V, 126.

Perennial; rhizome short, branched; leaves 30–60 cm long, membranaceous, oblong, naked, bipinnatifid; stipes stramineous, at base dark castaneous, chaffy, the scales narrow, pointed, brown with light margins; rachis sparsely covered with scales; lower pinnae somewhat shorter and more distant, the others narrowly lanceolate and prolonged into a long crenate point; pinnules sessile or borne on very short petioles, ovate-rhomboid or oblong, acute, distinctly lobed or toothed; veins feathery or forked; sori horseshoe-shaped, along the midrib; indusia membranous, naked, persistent, entire. July, August. (Plate II, Figure 5a).

Thin deciduous woods and thickets. — Far East: Uss. (only extreme S.). **Gen. distr.:** Jap. -Ch. Described from Japan. Type in Paris.

9. **A. Göringianum** (Knze.) Moore Ind. (1860) 185. — *Aspidium Göringianum* Knze in Bot. Zeit. (1848) 557. —

Perennial; stipes clothed with narrow scales; fronds triangular-oblong, tapering to a point, subcoriaceous, bipinnatifid, glabrate; pinnae

subsessile, broadly lanceolate, long-acuminate, pinnatifid, the lower ones petiolate; pinnules oblong, contiguous, point-tipped, with few very sharp elongated teeth and a long sharp tooth on the outer margin of the segments; sori brown, at the base of the acute segments and teeth; indusia coriaceous, brown; spores elliptic, plicate-rugose. August.

Broad-leaved woods on mountain slopes. — Far East: Uss. **Gen. distr. :** Jap. -Ch. Described from Japan.

10. **A. Wardii** (Hook.) Makino in Bot. Mag. Tokyo XIII (1899) 15; Fom. in Fl. Sib. et Or. Extr. V (1930) 129. — *Asplenium Wardii* Hook. Sp. Fil. 3 (1860), tab. 189.

Perennial; leaves large, deltoid-oval, 30–50 cm long, 35–40 cm broad or larger (var. major Makino), but with narrow pinnules and sori in two rows all the way up, bipinnatifid, naked; stipes covered with dark brown chaff; pinnae about 10 pairs, lanceolate, acuminate, 5–20 cm long, 4–6 cm broad; pinnules short-petioled, oblong-lanceolate, obtuse but with a sharp tooth at apex, faintly serrate, cuneate at base, with a conspicuous rounded-ovate toothed auricle on the outer margin; rachis smooth, grayish; veins of pinnules pinnately branched, the lower forked; sori oblong, slightly curved, in two rows; indusia slightly toothed or entire; spores ovate-reniform, brown. August.

Broad-leaved woods. — Far East: Uss. (sporadic). **Gen. distr. :** Jap.-Ch. Described from Japan. Type in Tokyo.

11. **A. crenatum** (Sommerf.) Rupr. in Beitr. z. Pflanz. d. Russ. R. III (1845) 40; Kryl., Fl. Zap. Sib. 1, 35. — *Aspidium crenatum* Sommerf. in Acta Holm. Sw. Vet. Akad. Handl. (1834) 104. — *Asplenium crenatum* Fries Summ. Veget. Scand. (1846) 82; Ldb. Fl. Ross. IV, 518. — *A. sibiricum* Turcz. Cat. Baikal., No. 1347 (1838). — *Athyrium mite* H. Christ in Bull. Acad. Int. Geogr. Bot. VI (1909) 148. — *Ath. idoneum* Kom. in Bull. Jard. Bot. Petr. XVI (1916) 148.

60 Perennial; rhizome long, creeping, branched; leaves 30–45 cm long; stipes long, with blackish or black chaff; fronds deltoid or broadly triangular (var. mite Fom.), membranaceous, bi- or tripinnatifid, pubescent beneath; pinnae oblong-lanceolate; pinnules petiolate, oblong, sometimes erose-sinuate (var. idoneum Kom. pro sp.); ultimate segments oblong, crenate or incised-crenate; sori ovate or round, along the midrib; indusia convex, membranous, long-ciliate on the margin; spores elliptic, plicate. July, August.

Coniferous and mixed woods, in rather dry mossy soil. — European part: Kar. -Lap., Lad. -Ilm., Dv. -Pech.; W. Siberia: Ob, Alt.; E. Siberia: Yen., Ang. -Say., Dau.; Far East: Sakh., Ze. -Bu., Uss. **Gen. distr. :** Scand., Jap. -Ch. Described from vicinity of Kandalaksha on the White Sea. Type in Leningrad.

12. **A. spinulosum** (Maxim.) Milde in Bot. Ztg. (1866) 376. — *Cystopteris spinulosa* Maxim. Prim. Fl. Amur. (1859) 340. — *Asplenium spinulosum* Baker Fil. (1874) 225. — Ic.: Fom. in Fl. Sib. et Or. Extr. V, 136; Kom. and Al., Opred. 1, Plate 10.

Perennial; rhizome creeping, branched; stipes slender, with brown chaff, longer than the dark green broadly deltoid long-tapering frond; rachis pubescent; lowest pinnae petioled, broadly lanceolate from a

narrower base, acuminate, the upper oblong-lanceolate to linear-lanceolate; pinnules lanceolate to oblong-lanceolate, pinnatifid; upper ultimate segments oblong from a broad base, sharply incised-serrate, with sharp tapering teeth, the veins pinnately branched; sori round or horseshoe-shaped, in rows along midrib and close to lobe incisions; indusia convex, membranous, fringed; spores ovate-elliptic, plicate-rugose. July, August. (Plate II, Figure 6 a-c).

Coniferous and mixed woods.— Far East: Uss., Uda, Sakh. **Gen. distr. :** Jap.-Ch. Described from the lower reaches of the Amur. Type in Leningrad.

Genus 11. **PHYLLITIS** LUDWIG

Ludwig in Inst. Hist. Phys. Regni veget. ed. II (1757) 142.

Sori linear, parallel, oblique to midrib; indusia paired, linear, the pair at first contiguous, then curving back to uncover sori; leaves undivided; stipes not jointed.

Ph. scolopendrium was found in fossilized state in M. Dnp. in Quaternary tuffs of Kashkad at village of Mushkutynets in Podolia, on the Studenke River.

1. **Ph. scolopendrium** (L.) Newm. Hist. brit. Ferns, ed. II (1844) 10.— *Asplenium scolopendrium* L. Sp. pl. (1753) 1079.— *Scolopendrium vulgare* Sm. Act. Taurin. V (1790) 421.— Ic.: Sm., 1. c., tab. 9, fig. 2.

Perennial; rhizome short, chaffy at the top; leaves coriaceous, naked, lance-lorate from a cordate base, acute to obtuse, the margin very slightly sinuate or entire, the stipe short; leaf rachis thickened, midriblike, sparingly covered with scales beneath; sori apparently in pairs, not reaching the midrib or the margin; spores reniform, brown. July, August.

Shaded rocks.— European part: M. Dnp.; Caucasus: Cisc., Dag., E. Transc., W. Transc., Tal. **Gen. distr. :** Atl. and Centr. Eur., Med., Atl. N. Am. Described from Europe. Type in London.

Genus 12. **CAMPTOSORUS** * LINK.

Link. Sp. Fil. (1806) 83: Hort. Berol., II (1833) 69.

Sori unilateral, covered with lateral indusium, the inner parallel to midrib, the outer ones inclined or marginal; stipes not jointed; scales as in the genus *Asplenium*; spores brown, with a single stripe.

1. **C. sibiricus** Rupr. Distr. crypt. (1845) 45; Ldb. Fl. Ross. IV, 622.— *Scolopendrium sibiricum* Hook. in Hook.-Bak. Syn. Fil. (1860) 248; Fedch. and Fler., Ill. opred. rast. Sib., p. 25.— Ic.: Fedch. and Fler., Opred. rast. Sib., 1. c., Figure 27.

Perennial; rhizome short, ascending, covered at the top with black chaff; leaves varying from broadly lanceolate and short-stipitate to lance-linear and relatively long-stipitate, long-acuminate and flagellate-tipped, tip-rooting; sori scattered, oval to oblong; indusia entire, undulate-margined; stipe with a thick midrib, channeled at the margin, the vascular bundle triangular or quadrangular; spores rugose-plicate to toothed-plicate. June-September.

* From Greek *camptein*, to bend, and *soros*, heap, pile [sorus].

Moss-covered rocks.— E. Siberia: Ang.-Say., Dau.; Far East: Ze.-Bu., Uss. **Gen. distr.:** Jap.-Ch. Described from Irkutsk. Type in Leningrad.

Genus 13. ASPLENIUM* L.
Gen. pl. (1737) 783; Sp. pl.2 (1753) 1078.

Sori single, oblong or linear, borne on one side of secondary veins; indusium of the same shape as sorus, attached to the fertile vein by the outer side, the inner side free; stipe not jointed; fibrovascular bundle of 3 or 4 joints or two oval bundles united by a narrow crosspiece; cells of scales at the base of stipe short, hexagonal or 5- or 4-angled, with cancellate walls.

Fossilized remnants of the following species have been found: *Asplenium Czekanowskianum* Heer.— in Tertiary layers of Lena-Kol. (Chirimyskaya), *A. Dicksonianum* Heer. (?)— in the Eocene of M. Dnp. (Putivl) doubtful remnants; *A. Glehnianum* Heer.— in Tertiary layers of Sakh. (Mgach) (possibly chalk); — *Asplenites* sp.— in Tertiary layers of Balkh. (Ashutas).

1. Leaves simply pinnate, with short stipe and numerous small rounded segments 2.
- + Leaves twice or thrice parted or bi- or tripinnate 3.
2. Leaf rachis reddish-brown or blackish-brown all the way up, elastic, angled, naked; pinnae sessile or nearly so 5. **A. trichomanes** L.
- + Leaf rachis reddish-brown only below the pinnae, green above, terete, channeled; stipe covered with scattered long hairs; pinnae borne on short slender petioles 4. **A. viride** Huds.
3. Leaves short, bipartite; segments terminal, narrow, linear, sparsely toothed on the margin; stipe long . . . 1. **A. septentrionale** (L.) Hoffm.
- + Leaves more or less elongated 4.
4. Leaves pale green, membranaceous, linear-lanceolate, bipinnate; middle pinnae ovate-rhombic; pinnules obovate, cuneate at base, the margin with broad obtuse teeth; spores plicate-rugose 6. **A. incisum** Thunb.
- + Leaves more or less coriaceous, pale or dark green 5.
5. Leaves linear in outline, pinnate in upper part, bipinnate below; rather small plants 6.
- + Leaves bipinnate or tripinnate 7.
6. Leaf segments short-linear or narrowly cuneate, with incised teeth in lower part; indusia entire 2. **A. germanicum** Weis.
- + Leaf segments somewhat broader, obovate-cuneate, crenate; indusia crenate-margined 3. **A. Heufleri** Reichard.
7. Pinnae mostly with ternate pinnules; indusia fringed; small plants 8.
- + Pinnae pinnate 10.
8. Pinnules and often their segments flabellate, incised-crenate, petiolate; sori close to base of segments; spores subtriangular-ovate, minutely warty and echinulate 8. **A. Hermannii** Christi Fom.
- + Pinnules different 9.
9. Pinnules ovate or cuneate-rhombic, incised-toothed above, petiolate, subcoriaceous, dull; spores nearly round, plicate-rugose 7. **A. ruta muraria** L.

* From a, negation, and splen, spleen, referring to the use of the plant as a cure for diseases of the spleen.

- + Pinnules narrowly cuneate, irregularly incised at apex, often confluent at base; spores ovate, echinulate 9. **A. samarcandense** Koss.
- 10. Rachis narrow-winged; frond lanceolate, strongly acuminate, finely bipinnatifid; pinnae lanceolate; pinnules very small, ovate, pointed; spores elliptic, granular, sparingly and narrowly plicate 12. **A. pseudo-fontanum** Koss.
- + Rachis wingless 11.
- 11. Pinnules finely dissected 12.
- + Pinnules larger 14.
- 12. Pinnae subopposite, the lowest 3-parted to the base; frond bipinnate, deltoid-oblong 13. **A. daghestanicum** H. Christ.
- + Pinnae alternate; frond bi- or tripinnatifid 13.
- 13. Pinnae oblong, asymmetric; pinnules oval-cuneate, sharply incised-toothed, petioled; veins very prominent; rachis channeled above 10. **A. Sarelii** Hook. var. **altajense** Kom.
- + Pinnae oblong, dissected to the base; pinnules very small, oval-cuneate to subflabellate, slender-petioled; with cuneate incised-toothed lobes; stipe not channeled 11. **A. anagrammoides** Christ.
- 14. Leaves subcoriaceous, to 15 cm long, oblong-lanceolate, finely bi- or tripinnatisect, narrowed toward base; pinnae elongate-lanceolate; pinnules oboval, sharply toothed; sori at center of segments 15. **A. pseudolanceolatum** Fom.
- + Leaves rigidly coriaceous, lustrous, often longer, 2-4-pinnate 15.
- 15. Leaves in upper part with entire pinnae resembling those of *A. viride*; lowest 2 or 3 pairs of pinnae pinnatifid; pinnules ovate, obtuse 14. **A. Woronowi** H. Christ.
- + Leaves 2-4-pinnatifid; all pinnae confluent, elongate-cuneate, often strongly pointed, sharply toothed; stipe reddish-brown, 16. **A. adiantum nigrum** L.

Section 1. **ACROPTERIS** Link Hortus Berol. II (1833) 53. Leaves evergreen, dichotomous or subpinnate, with 2 or 3 or rarely 5 pinnae.

1. **A. septentrionale** (L.) Hoffm. Deutschl. Fl. II (1795) 12; Kryl., Fl. Zap. Sib. 1, 36; Swartz Syn. Fil. 75; Ldb. Fl. Ross. IV, 521.—*Acrostichum septentrionale* L. Sp. pl. (1753) 1068.—Ic.: Moore and Lindl. Brit. Ferns tab. 41; Luer. Farnpfl. fig. 118.—Exs.: Sredinsky Herb. crypt. Ross., No. 5; HFR, No. 449.

Perennial; rhizome short, forked, clothed with linear brown scales; leaves coriaceous, dull, naked, long-stipitate, divided into 2-5 pinnae, these linear-elongate, long-cuneate at base and petioled, acuminate, entire or forked at apex into subulate lobes; veins apparently doubly dichotomously branching at an acute angle; sori narrowly linear, covering at maturity the entire undersurface of the leaf; indusia entire; spores brown, ovate-reniform, plicate-rugose. July, August.

Crevices of mostly noncalcareous rocks.—European part: Dv.-Pech., Lad.-Ilm., U. Dnp., M. Dnp., Bl., V.-Don, V.-Kama, Crim.; Caucasus: Cisc., Dag., W., S. and E. Transc., Tal.; W. Siberia: Ob (Tomsk), Alt., Irt.; Centr. Asia: Balkh., Dzu.-Tarb., T. Sh. **Gen. distr.**: W. and Centr. Eur., Scand., Bal.-As. Min., Him., N. Am. Described from Europe. Type in London.

Note. *A. septentrionale* × *ruta-muraria* Asch. und Graebn. Syn. 1 (1913) 116 = *A. Murbeckii* Dörfler Oest. Bot. Zeit. (1895) 223, a hybrid resembling *A. germanicum* Weis., but differing in stipe being reddish-brown merely at base and the segments broader. Occurring in Dagestan.

2. *A. germanicum* Weis. Pl. crypt. Flor. Gotting. (1770) 299.—*A. septentrionale* × *trichomanes* Murbeck in Lunds Un. Arsskr. XXVII (1892) 36.—*Scolopendrium alternifolium* Roth Tent. Fl. Germ. III (1800) 53.— Ic.: Moore and Lindl. Brit. Ferns. tab. 41, B; Luer. Farnpf. 239, f. 122.— Exs.: Herb. H. Christ (in Horto Tiflis.).

Perennial; leaves subcoriaceous, dull, narrowly lanceolate, naked, obtusish, pinnatifid or at base subbipinnate, pale green; stipe longer than frond, above the middle and at base castaneous, with articulate brown hairs; pinnae alternate, the lower 2–4 distant, short-petioled, with 2 or 3 segments, the others mostly undivided, the uppermost confluent into a single segment; segments cuneiform to linear-cuneiform, incised-toothed at apex; sori linear; indusia entire. August.

65 Granite rocks. European part: M. Dnp. Gen. distr.: Eur. Described from Germany.

3. *A. Heufleri* Reichardt in Verhandl. d. Zool. bot. Ges. zu Wien IX (1860) 95.—*A. trichomanes* × *germanicum* Luer. Farnpf. 250.— Ic.: Reichardt, l. c., t. 4; Luer. Farnpf., l. c., f. 123.

Perennial; rhizome as in the preceding; leaves pinnate, with ovate-cuneiform pinnae, irregularly crenate, the two lowest pinnae and sometimes each of them divided into 2 segments; stipe lustrous, castaneous, slightly longer than frond, this to 14 cm long; indusia crenate; spores obsolete.

Rocks. European part: V.-Kama (Mius R. near Novopavlovka). Described from the Tyrol. Type in Vienna.

Section 2. **EUASPLENIUM** Diels in Engl. u. Prantl. Nat. Pflanzf. 235. Leaves pinnate or 3- or 4-pinnatifid.

4. *A. viride* Huds. Fl. Angl. (1762) 385; Ldb. Fl. Ross. IV, 521; Kryl., Fl. Zap. Sib. 1, 38.— Ic.: Luer. Farnpf. 159, f. 106; Fedch. and Fler., Ill. Opred. rast. Sib. 28, Figure 29.— Exs.: Sredinsky, Herb. crypt. Ross., No. 2.

Perennial; rhizome with crowded crowns, almost naked, with narrow blackish scales; leaves 20 cm long, linear-lanceolate, simply pinnate; stipe slender, blackish or reddish-brown at base, green above; segments rhombic-ovate, cuneate at base, distinctly stalked, crenulate; sori oblong; indusia entire or very nearly so; spores rounded-oval, brown, with rather broad anastomosing folds, these finely toothed-margined. July, August.

Calcareous rocks, mostly in shade.— European part: Dv.-Pech., Lad.-Ilm., V.-Kama, Crim.; Caucasus (alpine and subalpine zones): Cisc., Dag., E. Transc.; W. Siberia: Ob (Tobol'sk, Tomsk), Alt.; E. Siberia: Yen., Ang.-Say.; Centr. Asia: T. Sh. Gen. distr.: mountains of Centr. Eur., Scand., N. Am.

5. *A. trichomanes* L. Sp. pl. (1753) 1080; Ldb. Fl. Ross. IV, 521; Kryl., Fl. Zap. Sib., 1, 37.— *A. microphyllum* Tineo in Guss. Fl. Sic. Prodr. II (1844) 884.— Ic.: Moore and Lindl. Brit. Ferns tab. 39; Luerss. Farnpfl. 185, f. 112; Fedch. and Fler., Ill. Opred. rast. Sib., Figure 28.— Exs.: Sredinsky, Herb. crypt. Ross., No. 3.

Perennial; caespitose; rhizome covered with black apparently nerved scales; leaves naked, simply pinnate; stipe and rachis black, lustrous, pinnae sessile or scarcely petiolate, obovate to suborbicular, or orbicular (var. *rotundatum* Milde), cuneate or truncate at base, sometimes auricled (var. *auriculatum* Milde), crenate, often incised to one-fourth (var. *inciso-crenatum* Asch.) or incised-crenate (var. *lobato-crenatum* DC), sometimes very small (var. *microphyllum* Milde); sori oblong; indusia entire or slightly sinuate; spores brown, irregularly reticulate-trabeculate. June, August.

Rock crevices, mostly in the shade of woods.— European part: Lad.-Ilm., V.-Kama, U. and M. Dnp., Bes., Bl. (Kherson), Crim., L. Don; Caucasus: Cisc., Dag., S. Transc., Tal.; Centr. Asia: Balkh., T. Sh., Pam.-Al. Gen. distr.: Eur., N. and S. Am. Described from Europe. Type in London.

Economic importance. Distinguished by a distinct aroma and used for prevention of baldness.

6. *A. incisum* Thunb. Trans. Linn. Soc. 2 (1794) 342.— Ic.: Fom., Fl. Sib. et Or. Extr. V (1930) 146, A, B, C.

Perennial; caespitose; rhizome short, clothed with narrow cancellately thickened black scales; leaves 10–20 cm long, 2.5–3 cm broad, lanceolate to linear-lanceolate, pointed at apex; stipe short, brown; frond often simply pinnatifid at first, at maturity often bipinnatifid; lowest pinnae stalked, rhombic-oval or rhombic-flabelliform; middle pinnae stalked, oval-triangular, pinnatifid, with broadly toothed segments, the teeth mucronulate; upper pinnae oval and divided into segments; sori oblong; indusia entire or slightly sinuate; spores elliptic, plicate-rugose. August, September. (Plate IV, Figure 5 a–c).

On limestone, on slopes, and in rock crevices.— Far East: Uss., Kamch., Sakh. Gen. distr.: Jap.-Ch. Type in Uppsala.

Section 3. **COMPOSITAE** Diels in Nat. Pflanzf. 1, 4, 239.

Leaves 2–4-pinnatifid.

7. *A. ruta muraria* L. Sp. pl. (1753) 1081; Ldb. Fl. Ross. IV, 427; Kryl., Fl. Zap. Sib. 1, 39; Fom. in Fl. Sib. et Orientis Extr. V (1930) 147.— *Scolopendrium ruta muraria* Roth Tent. Fl. Germ. III (1800) 52.— Ic.: Moore and Lindl. Brit. Ferns tab. 41, A; Fedch. and Fler., Ill. Opred. rast. Sib. 1, 28, Figure 31.

Perennial; rhizome short, clothed with linear-lanceolate blackish-brown scales; leaves triangular, triangular-ovate or ovate-lanceolate, 10–25 cm long, evergreen, subcoriaceous, dingy green, dull, naked or glandular, twice or thrice pinnately divided; stipes green, partly turning black; pinnae and pinnules petiolate, alternate or rarely opposite, distant; ultimate segments rhombic-oboval, large, roundish (var. *Matthioli* Heufl.) or rhombic-cuneate, incised-toothed (var. *pseudoserpentinii* Milde), or angular-rhombic and long-stalked (var. *abchasicum* Fom.),

rarely oblong-cuneiform, crenate or entire at apex, in 3's; sori linear, at length confluent; indusia ciliate-margined; spores rather large, subglobose, plicate-rugose. June, August.

Rocks and stony slopes, on limestone.— European part: Lad.-Ilm., V.-Kama, M.Dnp., Bes., V.-Don, L. Don, Bl., Crim.; Caucasus: Cisc., Dag., E., W. and S. Transc.; Centr. Asia: Balkh., Dzu.-Tarb., Pam.-Al., T. Sh.; W. Siberia: Irt., Alt.; E. Siberia: Yen., Ang.-Say., Dau.; Far East: Ze.-Bu., Uss. **Gen. distr.**: Eur., Him., E. states of N. Am. Described from Europe. Type in London.

8. **A. Hermanni-Christi** Fom. in Fl. Cauc. crit. 1 (1913) 229.

Perennial; rhizome short, clothed with narrow brown scales; leaves green, flabrous, deltoid-oblong, subcoriaceous, in dry condition translucent, to 2.5 cm long, bi- or tripinnatifid, to 1.5 cm broad at base; stipe twice the length of frond, brown at base; pinnae subtriangular-oblong, obtuse, petiolate; pinnules and their segments fan-shaped, cuneate at base, incised-crenate, stalked; sori close to base of segments, at length confluent; indusia fringed; spores trigonous-oval, verrucose-echinate, with occasional winged folds. July.

Walls of ruins.— Caucasus: W. Transc. (Abkhazia). Described from village of Koldakhvar. Type in Tiflis.

9. **A. samarcandense** Koss. in Notul. system. Herb. Hort. Petr. III (1922) 67.

Perennial; rhizome stout, ascending; leaves 2–3 cm long, 1.5–2 cm broad, bipinnatifid, oval to oblong-oval, obtuse, green; stipe to 7 cm long, covered with glandular hairs, brown at base; pinnae 4–6, alternate, irregularly rhombic, short-petioled or sessile; pinnules 2 or 3, cuneiform, unequally lobed, the middle lobes longer, irregularly crenate or sinuate, the fan-shaped veins entering into the crenulations; sori linear, 1–3 mm long, 0.5 mm broad; indusia irregularly fringed; spores broadly oval, echinulate. July. (Plate IV, Figure 2).

Rock crevices, in juniper woods.— Centr. Asia: Pam.-Al. (Samarkand, Shut, Revat). Described from Zeravshan River. Type in Leningrad.

10. **A. Sarelii** Hook. in Blakiston Yang-tze (1862) 363, 364.— **A. Saülii** Bak. in Hook. and Bak. Syn. Fil. (1874) 216.— **A. sepulchrale** Hook. Syn., ed. 1 (1867) 213.

68 Perennial; rhizome short; stipes 7–15 cm long, indurated, naked, erect, brown at base; leaves subcoriaceous, 15–20 cm long, 6–9 cm broad, deltoid, irregularly tripinnatifid; pinnae subdeltoid; pinnules lanceolate to oblong-lanceolate, obliquely truncate, cuneate at base, divided into linear-cuneate sharp-toothed segments; rachis rigid, naked; veins of segments obscure; sori oblong; indusia entire; spores covered with blunt flattish prickles. **Gen. distr.**: Jap.-Ch. Type in London.

Var. **altajense** Kom. in Bull. Jard. Bot. Petr. XVI (1916) 150.— Ic.: Fom. in Fl. Sib. et Or. Extr. V, 151.

Tufted fern with a short rhizome; leaves 5–7 cm long, 2–4 cm broad, linear to narrowly lanceolate, intensely green, with a long tapering point; pinnae 6–8 pairs; pinnules oboval, cuneate at base, toothed-incised, short-stalked, the veins prominent above; spores plicate and minutely echinulate. (Plate IV, Figure 3 a–d).

Shaded rocks.— W. Siberia: Irt., Alt.; E. Siberia: Ang.-Say. Described from Chuya and Chulyshman rivers. Type in Tomsk and Leningrad.

11. **A. anagrammoides** H. Christ in Fedde Repert. V (1908) 11.— Ic.: Fom. in Fl. Sib. et Or. Extr. V (1930) 153.

Perennial; rhizome short, erect; leaves clustered; stipes weak, clothed with short blackish setaceous scales; leaves to 6 cm long, oval, acuminate, 6 cm long, 3 cm broad, tripinnate; rachis flat, wingless; pinnae 8–10 on each side, alternate, slender-petioled, lanceolate, dissected, upright; pinnules numerous, oboval-cuneiform, subflabellate, 3 mm long, 2 mm broad, deeply and sharply dissected, stalked; their segments lanceolate, pointed or sometimes obtuse; veins forked, obscure; sori 1 on each ultimate segment and 3 per lobule, oval, inflated, reddish-brown, ca. 2 mm long; indusia oval, entire, brown, at length becoming wrinkled; spores slightly rugose. July.

Crevices of damp rocks, in the shade of woods.— Far East: Uss. **Gen. distr.**: Manch., Korea. Described from Manchuria. Type in H. Christ's herbarium in France.

12. **A. pseudofontanum** Koss. in Notul. System. Herb. Horti Petr. III (1922) 122.

69 Perennial; rhizome stout, oblique, clothed with brownish-gray scales; leaves to 20 cm long, slightly curved; frond to 12 cm long and 3 cm broad, narrowly lanceolate to lance-linear, long-acuminate, finely bi- or tripinnatifid; stipe 8 cm long, like the rachis narrow-winged; pinnae alternate; pinnules 13, stalked; segments small, unequal, point-tipped, the upper segments confluent; sori ovate, up to 3 per segment; indusia semiovate, white; spores broadly oval or roundish, granular, with narrow winged folds. June, July. (Plate IV, Figure 4 a–b).

Shaded side of rock crevices.— Centr. Asia: Amu D., Pam.-Al. **Gen. distr.**: Kuldja, Afghanistan, Kashmir, Nepal, and Punjab. Vicariad species of the European *A. fontanum* Bernh. Described from vicinity of Madm village on Zeravshan River. Type in Leningrad.

13. **A. daghestanicum** H. Christ in Monit. du Jard. bot. Tifl. VI (1906) 25.— Ic.: Fom. in Monit. Jard. bot. Tifl. XII, tab. 1.

Tufted; rhizome profusely rooting; leaves naked, subcoriaceous, dark green, to 7–8 cm long; stipe brown at base, 3–4 cm long, clothed with narrow setaceous brown scales and scattered hairs, filiform; frond 3–4 cm long and 1–1.5 cm broad, oblong, deltoid at base, acuminate at apex; pinnae 4–6 on each side, opposite, the lower distant and short-petioled, the lowest tripinnatifid down to base; segments broadly cuneiform to subflabellate, dissected into sharp teeth; sori 3 or 4 on each segment, brown, ovate, often confluent; indusia gray, oblong, entire. May, June.

Rocks.— Caucasus: Dag. Described from Kyurinskii District. Type in H. Christ's herbarium in France.

14. **A. Woronowi** H. Christ in Monit. du Jard. bot. Tifl. VI (1906) 25.

Perennial; rhizome short, erect; leaves clustered, coriaceous; stipe 6 cm long, tinged dark brown at base; frond 6 cm long and 2–2.5 cm broad, elongate-lanceolate, obtusish, bipinnate; pinnae 8–11, the lower subpetiolate, distant, ovate, obtuse, unequal, deeply incised at base; lowest pinna

cuneiform-ovate, free, obtuse, with 3 rounded-ovate lobes on each side at apex, crenulate on the margin; pinnules incised-toothed; sori oblique, 2 or 3 on each segment; indusia entire; upper part of the frond resembling *A. viride* var. *incisum*. July.

Calcareous rocks in the alpine zone.—Caucasus: W. part of Gr. Cauc. (Abkhazia, the pass between Akhagvash and Arbika). Described from this location. Type in Tiflis.

15. *A. pseudolanceolatum* Fom. in Fl. Cauc. crit. I, 1 (1912) 137.

70 Perennial, caespitose; rhizome clothed with narrow brown scales; stipes long, brown at base; leaves soft, lanceolate, acute, bipinnatifid to the middle; pinnae oblong-lanceolate or oblong, the cuneate base passing into petiole, the margin sharply toothed; pinnules mostly 3-parted; sori oblong, at middle of pinnules; indusia entire; spores ovate, brown, reticulate-rugose. June, July.

On crags consisting of noncalcareous rocks, alpine and subalpine zones.—Caucasus: W. and E. Transcaucasia. Described from vicinity of Borzhomi. Type in Tiflis.

16. *A. adiantum nigrum* L. Sp. pl. (1753) 1081; Fom. in Fl. Cauc. crit. 1 (1912) 132.—Ic.: Moore and Lindl. Brit. Ferns tab. 36.—Exs.: Sredinsky Herb. crypt. ross., No. 6.

Perennial; rhizome erect, black, clothed with narrowly lanceolate scales; leaves perennial, lanceolate to ovate, acuminate, coriaceous, lustrous; frond bi- or tripinnate; pinnae distant, sometimes directed upward; ultimate segments ovate or obovate, cuneate at base, mostly straight, distant, the margin toothed; teeth obtuse (var. *obtusum* Milde) or ultimate segments narrowed at base and teeth sharp (var. *lancifolium* Heufl.), or frond lustrous and teeth sharp (var. *argutum* Heufl.); stipe as long as or longer than frond, blackish-brown, lustrous; indusia entire; spores ovate-reniform, with anastomosing wings. July, August.

Shaded, predominantly siliceous rocks.—European part: M. Dnp. (Kamenets-Podol'skii), Crim.; Caucasus: Cisc., Dag., W. and E. Transc., Tal.; Centr. Asia: T. Sh. **Gen. distr.**: Atl. Eur., Centr. Eur., Med. Described from Europe. Type in London.

Genus 14. **PLEUROSORIOPSIS** * FOM.

Fom. in Bull. Jard. Bot. Kieff XI, 1930, 8–9.

Sori borne along the forked veins, these thickened at the tips; indusia wanting; spores ovate-reniform; stipes not jointed; rhizome very slender, creeping.

1. *P. Makinoi* (H. Christ) Fom. Bull. Jard. bot. Kieff XI (1930), 8–9.—Anogramme Makinoi H. Christ in C. Christens. Ind. Fil. (1905), 58.—Gymnogramme Makinoi Maxim. apud Makino in Tokyo Bot. Mag. VIII (1894) 481.—Ic.: Fom. in Fl. Sib. et Or. Extr. V, 216.

Perennial; rhizome creeping, very slender, clothed with scalelike hairs; leaves small, 3–5 cm long and 1.5–2 cm broad, oblong, twice pinnatisect, covered on both sides with short articulate hairs; stipe half as long as frond, clothed with hairs and long capillary ferruginous-brown scales;

* From Greek *pleura*, film, *soros*, heap, and *opsis*, appearance, i.e., resembling *Pleurosorus*.

71 pinnae ovate-oblong or ovate-rhombic, cuneate at base, petiolate; pinnules obovate, with 2—5 small toothlike lobes; sori reniform-ovate, almost smooth. June, August. (Plate III, Figure 3 a—d).

Damp rocks in woods, in carpets of *Climacium japonicum* moss.— Far East: Uss. **Gen. distr.**: Jap.-Ch. Described from Japan. Type in Leningrad.

Genus 15. **CETERACH** * WILLD.

Willd. Sp. pl. V (1810) 136.

Sori linear, unilateral, oblique, interspersed with thin scales; indusia wanting; veins branched and anastomosing.

1. **C. officinarum** Willd. Sp. pl. V (1810) 136.— *Asplenium ceterach* L. Sp. pl. (1753) 1080.— *Gymnogramme ceterach* Spreng. Syst. veget. IV (1786) 38 (pp.).— Ic.: Fedch. and Fler., Fl. Evrop. Rossii, Figure 11; Moore et Lindl. Brit. Ferns tab. 43; Luer. Farnpfl. 283, f. f. 128—130.— Exs.: Sredinsky Herb. crypt. Ross., No. 23.

Perennial, tufted; leaves subcoriaceous, lanceolate, obtuse, simply pinnate; segments ovate-orbicular, dull pale green and naked above, the underside like the short stalk clothed with imbricated brown triangular-lanceolate scales, these concealing the sori; spores ovate-reniform, covered with blunt prickles. July, August.

Rock crevices exposed to the sun, from sea level to the subalpine zone; in dry condition the leaves rolling up into a tube.— European part: Crim.; Caucasus: Cisc., W. and E. Transc., Tal.; Centr. Asia: Mtn. Turkm., Amu D., Syr D., Pam.-Al., T. Sh. **Gen. distr.**: Eur., Med., Him. Described from Europe. Type in Berlin or in London.

Genus 16. **BLECHNUM** ** L.

L. Sp. pl. (1753) 1077.

Fossilized in the Pliocene of E. Transcaucasia (Shiraki).

Sori linear, borne uninterruptedly along the midrib of lateral leaf segments and occupying the space between midrib and the marginal anastomoses of lateral veins, at length confluent; indusia marginally attached, scarious, free on the inside; stipes not jointed.

1. **B. spicant** With. Bot. Arrang. ed. 3 (1796) 765; Shmal'g. II, 688; Fom. Fl. Cauc. crit. 1 (1912) 143.

72 Perennial, tufted; rhizome oblique, clothed at the top with blackish scales; leaves pinnately parted, dimorphous; sterile fronds short-stipitate, elongate-lanceolate, to 50 cm long, with obtusish entire segments; fertile fronds with longer stipes and pointed segments; indusia scarious; spores brown, with flexuous folds. July, September.

Woods, mostly coniferous, heavily shaded.— European part: M. Dnp. (Podolia); Caucasus: W. and S. Transc. (Tiflis, Borzhomi), Tal. **Gen. distr.**: Atl. Eur., Centr. Eur., Jap.-Ch., N. Am. Described from Europe. Type in London.

* A name that passed into medieval Latin from Arabic or German, referring to scab.

** From Greek *blechnon*, synonymous with *pteris*, fern.

Genus **WOODWARDIA** * SM.

In the USSR only fossilized. The following have been found: *Woodwardites arcticus* Heer, in Paleocene layers along Tavda River in Ob region; *Woodwardia* sp. in the Eocene of the Anadyr River, between Omacha and Cape Telegraficheskii; *W. orientalis* Sw. in the Pliocene of W. Transcaucasia (Goderskii Pass).

Subfamily 5. **Pterideae** Diels

Key to Genera

1. Sori along fan-shaped veins; small annual or biennial plants, with tripinnatifid leaves; stipes short, reddish-brown; fertile leaves lanceolate, with longer stipes 17. **Anogramma** Link.
- + Disposition of sori different 2.
2. Sori linear, borne along the veins; leaves pinnate or bipinnate 18. **Coniogramma** Fée.
- + Sori borne on thickened tips of veins or on an intermarginal anastomose joining ends of veins 3.
3. Fertile and sterile leaves as well as their segments alike 4.
- + Fertile leaves differing from the sterile, their segments semi-cylindrically revolute 21. **Cryptogramma** R. Br.
4. Sori borne on a distinct scarious revolute lobe of the segments, these borne on capillary petioles. 22. **Adiantum** L.
- + Sori not borne on a distinct lobe of segments 5.
5. Sori in a linear row near the margin of segments, borne on marginal anastomoses 6.
- + Sori not arranged in a linear row 7.
6. Leaves pinnate, with 5—9 pairs of linear-lanceolate segments; sori covered by a reflexed margin of segments 23. **Pteris** L.
- + Leaves bi- or tripinnatifid; sori covered on one side by the reflexed margin of segment, on the other side by indusium, this parallel to the segment margin 24. **Pteridium** Gled.
- 73 7. Sori borne on thickened tips of veins, covered by the reflexed margin of segments; small plants with decompound leaves 20. **Cheilanthes** Sw.
- + Sori on slightly thickened ends of veins along the margin of the segment; the lower surface densely covered with reddish-brown imbricated scales 19. **Notholaena** R. Br.

Genus 17. **ANOGRAMMA** ** LINK

Fil. Sp. (1841) 137.

Sporangia running rather densely along the length of veinlets; leaves pinnatifid, not jointed; spores tetrahedral-globose, with 3 stripes.

1. **A. leptophylla** (L.) Link Fil. Sp. (1841) 137.—*Polypodium leptophyllum* L. Sp. pl. (1753) 1092.—*Gymnogramme leptophylla* Desv. ex Boiss. Fl. Or. V (1884) 721.—Ic.: Moore et

* Named for the English botanist Th. J. Woodward (1745—1820).

** From Greek *ano*, above and *gramma*, line, alluding to position of sori on the upper segments.

Lindl. Brit. Ferns tab. 43; Luer. Farnpf. 61, f. 68, 69; Fedch. and Fler., Fl. Evrop. Rossii, Figure 13.

Annual, tufted; leaves delicate, membranaceous, translucent, short, glabrous; stipe reddish-brown; fronds dimorphous, some reniform with fan-shaped segments, others ovate-lanceolate, thrice pinnatisect with obovate-cuneate lobed segments; sori along the secondary veins in oblong-linear rows, becoming confluent; spores brown. (Plate IV, Figure 7 a—c).

Spring plants growing in clayey soils and on damp shaded rocks.— European part: Crim.; Caucasus: W. Transc. **Gen. distr.:** Atl. Eur., Med. Described from S. Europe. Type in London.

Genus 18. **CONIOGRAMMA** * FÉE

Fée Genera Fil. (1850) 167

Sori linear, along the veins; spores globose-tetrahedral; rhizome creeping; stipes not jointed, with a single semicylindric vascular bundle; leaves simply pinnate or bipinnate, glabrous or slightly hairy; venation dense, pinnately spreading with forking free or anastomosing ramifications, the tips of veinlets thickened.

1. **C. fraxinea** (Don) Diels in Nat. Pflanzf. I, 4 (1902) 262.— *Diplazium fraxineum* Don Prodr. Fl. Nepal. (1825) 12.— Ic.: *Gymnogramme javanica* Blume Fil. Jav. (1829) 95, tab. 41; Fedch. and Fler., Ill. Opređ. rast. Sib., Figure 33.

74 Perennial; rhizome creeping; stipes 0.3—1.2 m long; leaves simply pinnate or bipinnate, glabrous or nearly so, ovate or deltoid-ovate, pale green; terminal portion of leaf simply pinnate, terminating in an apical segment; pinnae lanceolate, long-tapering at apex, 10—15 cm long and 2 cm broad, slightly narrowed or rounded at base, crenulate, stalked; pinnules shorter, stalked or sessile and decurrent; veins feathery, forking; sori linear. July–September.

Mixed woods and mountain slopes.— Far East: Uss., Sakh. **Gen. distr.:** Jap. - Ch.

Genus 19. **NOTHOLAENA** ** R. BR.

R. Br. Prodr. Fl. Nov. Holland. (1810) 145.

Sori marginal, oblong-orbicular; indusia wanting; margins of fertile leaves revolute; leaves bipinnate, clothed beneath with scales or soft hairs, these covering the sori; stipes not jointed.

1. **N. Maranthae** † (L.) R. Br. Prodr. Fl. Nov. Holl. (1810) 145; Fom. in Fl. Cauc. crit. I (1912) 147.— *Acrostichum Marantae* L. Sp. pl. (1753) 1071.— *Gymnogramme marantae* Mett. Fil. Hort. Lips. (1856) 43.— Ic.: Luer. Farnpf. f. 70, 71.— Exs.: HFR, No. 249.

Perennial; rhizome creeping, densely clothed with scales; stipes long; leaves coriaceous, elongate-lanceolate, bipinnatifid, green above, densely covered beneath with narrowly lanceolate pointed rufous scales; pinnules

* From Greek *conios*, dust, and *gramma*, line, alluding to the linear disposition of spores.

** From Greek *nothos*, spurious, and *chlaena*, cloak, referring to the absence of a proper indusium.

† After the name of the Italian physician Maranti who was the first to describe this genus in 1559.

oblong, obtuse, entire, the lowest pinnately lobed; secondary veins repeatedly forking; sori distributed throughout from base to apex; spores brown, bluntly echinate. July-September.

Dry rocks. — European part: Crim.; Caucasus: Cisc., Dag., W., E. and S. Transc. **Gen. distr.:** Atl. Eur., Med.

Note. Interesting for its xerophytic properties and drought resistance.

Genus 20. **CHEILANTHES** * SW.

Sw. Syn. Fil. (1806) 126.

Sori terminal, borne on the thickened tips of veinlets, round, sometimes elongate, at length confluent, often forming a flexuous line at some distance from the margin, covered with a modified often reflexed margin of the lobes; spores globose-tetrahedral; rhizome mostly short, ascending or creeping, clothed with scales; stipes not pointed; veins free.

- 1. Ultimate segments small, convex, inflated; margin passing into a thin dense long fringe, this covering the entire sorus from beneath with wooly pubescence; rhizome clothed with blackish-brown to almost black scales 4. **Ch. persica** Mett.
- + Ultimate segments not inflated; margin mostly interrupted 2.
- 2. Ultimate segments but slightly larger than in the preceding species, narrowly oblong, not inflated; margin of segments above the sorus scarious, minutely ciliate, thus the underside of segments apparently glabrous; rhizome clothed with reddish-brown scales 3. **Ch. pteridioides** (Reich.) C. Christens.
- + Ultimate segments much larger 3.
- 3. Leaves membranaceous, oblong-lanceolate, bipinnatifid, covered above and beneath with stalked glands; pinnae subsessile; pinnules 5 or 6 on each side, pinnately parted, decurrent as a narrow wing on the rachis 2. **Ch. Kuhnii** Milde.
- + Leaves subcoriaceous, cordate-pentagonal, smooth above, covered beneath with a white waxy bloom (this lacking in var. *obscura* H. Christ).. . . . 1. **Ch. argentea** (S. G. Gmel.) Knze.

Section 1. **EUCHEILANTHES** Hook. ex Diels in Nat. Pflnzf. I, 4 (1902)

275. Margin of segments mostly interrupted; ultimate segments not orbicular and not convex.

1. **Ch. argentea** (S. G. Gmel.) Knze. in Linnaea XXIII (1850), 242. — *Pteris argentea* S. G. Gmel. Nov. Comm. Petr. XII (1768) 519. — *Allosorus argenteus* Presl. Tent. Pterid. (1836) 153. — Ic.: H. Christ Farnkr. d. Erde 149, f. 438; Fedch. and Fler., Ill. opred. rast. Sib., Plate I; Kom. and Alis., Opred. I, Plate 13.

Perennial; rhizome short, ascending, clothed at the top with crowded narrow blackish lustrous scales; stipes often much longer than the blade, lustrous, reddish-brown, glabrous; leaves subcoriaceous, dull, glabrous above, covered with a white waxy bloom, rarely without bloom (var. *obscura* H. Christ), cordate-pentagonal, deeply 3-parted; segments pinnatisect, the lateral ones opposite; terminal segment short-cuneate,

* From Greek cheilos, margin, and anthos, flower, from the marginal sori.

regularly pinnatisect, with oblong obtuse crenulate lobes; veins simple, reaching the sinuses of the crenulations, thickened and bearing sori at the tips; indusia false, abruptly tapering, membranous, plicate and regularly crenate; spores brown. July-September.

Rocks, especially calcareous, and stony slopes. — W. Siberia: Alt.; E. Siberia: Yen., Ang.-Say., Lena-Kol. (Vitim), Dau.; Far East: Ze.-Bu., Uss., Okh. **Gen. distr.**: Jap.-Ch. Described from Dauria. Type in Leningrad.

2. **Ch. Kuhnii** Milde Fil. Eur. (1867) 35. — Ic.: Fom. in Fl. Sib. et Or. Extr., V (1930) 158—159.

Perennial; rhizome short, oblique, clothed with broad ovate fringe-tipped scales; leaves membranaceous, to 20 cm long and 5 cm broad, sparingly covered with short stalked glands; stipes narrowly channeled, glabrate, lustrous, castaneous; fronds oblong-lanceolate, bipinnate, with a shining brown main rachis; pinnae subsessile, obtusish; pinnules 5 or 6 on each side, narrowly oblong, obtuse, deeply pinnatisect, with crenulate lobes; veins translucent; sori borne at the tips of crenulations; spores tetrahedral, brown. June-August. (Plate VI, Figure 9 a—c).

Damp rock fissures. — Far East: Ze.-Bu. **Gen. distr.**: Jap.-Ch. (Manchuria, Korea). Type in Leningrad.

3. **Ch. pteridioides** (Reich.) C. Christens. Ind. Fil. (1905) 178; Fom. in Fl. Cauc. crit. I (1912) 150. — *Ch. fragrans* Webb et Berth. Hist. nat. d. îles Canar. III (1836—50) 452. — *Polypodium pteridioides* Reich. Syst. pl. nov. IV (1780) 404.

Perennial; rhizome creeping, clothed with blackish-brown scales; leaves short, dull green, coriaceous, glabrous above, sometimes glandular beneath, ovate-oblong, thrice pinnatifid; stipes shining brown or black, very slender, like the rachis covered with scales; pinnae triangular; ultimate segments very small, narrowly oblong, obtuse, the lowest obtusely lobed, the uppermost entire, confluent; margin of fertile segments continuous or interrupted, scarious, smooth or minutely ciliolate. June, July.

Fissures of shaded calcareous rocks. — Caucasus: Dag.; Centr. Asia: Mtn. Turkm. (Dzhebel). **Gen. distr.**: Atl. Eur., Med., Iran. (Afghanistan) and Asia Minor. Described from the Mediterranean region.

Section 2. **PHYSAPTERIS** Presl. Tent. Pterid. (1836) 160. — Leaves more or less hairy; ultimate segments rounded, inflated, the margins enclosing the sori in a more or less complete ring.

4. **Ch. persica** (Bory) Mett. ex Kuhn Bot. Ztg. XXVI (1868) 234. — *Notholaena 1 persica* Bory in Belang. Voy. aux Ind. Or. Crypt. (1833). 23. — *Ch. Szovitsii* F. et M. in Hohenacker Enum. Elisab. (1833) 260 et in Bull. Moscou III (1838) 241. — Ic. Hook. Sp. Filic. II, tab. 94.

Perennial, tufted; rhizome clothed with blackish-brown scales; leaves coriaceous, oblong-lanceolate, glabrous above, densely hairy beneath; segments extremely small, inflated, orbicular or ovate; margins of segments inrolled, scarious, covered with long brown hairs; stipes brittle, covered with hairs and scales; spores globose, granular, with 3 stripes. July-August.

Crevices of rocks, especially calcareous.— European part: Crim.; Caucasus: Dag., E. and S. Transc.; Centr. Asia: Mtn. Turkm., Pam.-Al., T. Sh., Syr D. **Gen. distr.:** Med., Asia Minor, Him. Described from E. Mediterranean.

Genus 21. **CRYPTOGRAMMA** * R. BR.

Apud Richardson in Frankl. Narr. of Am. jour., (1833) 767.

Sori without indusia, round, becoming confluent, concealed under the inrolled leaf margin; fertile leaves differing from the sterile; stipes not jointed; spores tetrahedral-globose, with 3 stripes.

1. Rhizome short; leaves approximate 2.
- + Rhizome slender, elongate; leaves scattered, the vegetative segments thin and translucent 4. **C. Stelleri** (S. G. Gmel.) Prantl.
2. Leaves ovate-triangular, tri- or quadripinnatifid, subcoriaceous; ultimate segments linear, short, slightly pointed; ends of veinlets thickened and concave; scales at the base of stipe brown, concolorous 3. **C. Raddeana** Fom.
- + Leaves ovate 3.
3. Ultimate vegetative segments ovate-oblong from cuneate base, obtuse, more or less crenate; vein-tips gradually enlarged; scales at the base of stipes concolorous brown 1. **C. crispa** (L.) R. Br.
- + Ultimate vegetative segments more dissected, the strongly thickened veins with clavate tips; scales at the base of stipes brownish, with a blackish-brown median band 2. **C. acrostichoides** R. Br.

Section 1. **EUCRYPTOGRAMME** Prantl in Engl. Bot. Jahrb. III (1882) 414.

Sori on the free vein-tips; spores pale, warty; leaves commonly dimorphous; stipes with a single vascular bundle.

1. **C. crispa** (L.) R. Br. in Richards. Bot. app. Frankl. Journey (1823) 767.— *Allosorus crispus* Bernh. in Schard. Journ. 1, 2, (1806) 36; Ldb. Fl. Ross. IV, 525.— *Pteris crispa* All. Fl. pedem. II (1785) 284.— *Osmunda crispa* L. Sp. pl. (1753) 1067.— Ic.: Fedch. and Fler., Ill. opred. rast. Sib. 30, Figure 34; Fedch., Fl. Zabaik., Figure 9; Fom. in Fl. Sib. et Or. Extr. 165.

78 Perennial; rhizome creeping, branched; plant glabrous throughout; leaves ovate-lanceolate, tri- or quadripinnatifid; sterile leaves shorter than the fertile; ultimate segments of sterile leaves ovate-oblong from cuneate base, obtuse, dissected-crenate at apex; ultimate segments of fertile leaves narrowed, oblong-linear, appearing roundish due to inrolled margins; veins forking, gradually thickened at tips; sori elliptic; spores yellowish, densely verrucose. July, August.

Rock crevices and taluses.— European part: Urals; W. Siberia: Ob(N.); Caucasus: Cisc., Gr. Cauc., Dag. **Gen. distr.:** Atl. Eur., Scand., mountains of Centr. and S. Eur., Asia Minor. Described from Europe. Type in London.

* From Greek cryptos, hidden, and grammar, a line, referring to the sori concealed under the leaf margin.

2. *C. acrostichoides* R. Br. in Franklins Journ. (1823) 754, 767.—*Allosorus acrostichoides* Sprgl. Syst. (1827) 63.—*A. foveolatus* Rupr. Distr. Crypt. (1845) 46; Ldb. Fl. Ross. IV, 525.—*Gymnogramme acrostichoides* Presl. Tent. Pterid. (1836) 219.—Ic.—Fom. in Fl. Sib. et Or. Extr. V, 167.

Perennial; rhizome short, clothed with scales; leaves approximate, the fertile longer than the sterile; stipes 5–15 cm long, covered at base with scales, these with a black median band; leaves ovate to ovate-lanceolate, glabrous, subcoriaceous, bipinnatifid; pinnae stalked, ovate, obtuse, with 4–7 pairs of oblong obtuse crenate pinnules; segments of fertile leaves linear, with folded margins; sori ovate; spores brownish, granular. July. (Plate II, Figure 8 a–c).

Rock fissures, only in proximity of the sea.—Far East: Kamch.

Gen. distr.: N. Am. Described from shores of Nutka Strait. Type in London.

3. *C. Raddeana* Fom. in Fl. Sib. et Or. Extr. V (1930) 169.—Ic.—*ibid.* 171.

Perennial; rhizome short; stipes 12–16 cm long, clothed at base with brown unicellular scales; sterile leaves ovate-triangular, subcoriaceous, 3–5 cm long, tetrapinnatifid, with 5 or 6 pairs of ovate-triangular pinnae; pinnules thin, membranaceous, ovate to ovate-triangular; ultimate segments short, linear, acute or obtuse, dichotomously branched at the ends; tips of the pinnately spreading veinlets in the small terminal dichotomous segments clavate; fertile leaves bipinnatifid, longer than the sterile; ultimate segments of fertile leaves initially linear-lanceolate, becoming ovate in maturity; spores obtusely tetrahedral, verrucose. July, August. (Plate III, Figure 1 a–d).

Rocks and screes.—E. Siberia: Ang.-Say., Dau. **Gen. distr.:** China. Described from the shores of Lake Baikal. Type in Leningrad.

4. *C. Stelleri* Prantl in Engler Bot. Jahrb. 3 (1882) 413.—*Pteris Stelleri* S. G. Gmel. Nov. Comment. Ac. Petrop. 12 (1768) 519.—*Allosorus Stelleri* Rupr. Distrib. Crypt. (1845) 47–48.—*A. gracilis* Presl Tent. (1836) 153.

Perennial; rhizome slender, creeping, sparsely clothed with scales; sterile leaves membranaceous, translucent, ovate to ovate-oblong, subbipinnate, 5–15 cm long, 2–5 cm broad; pinnae 3 or 4 pairs, oblong; pinnules slightly crenate, obovate, decurrent; fertile leaves bipinnatifid, oblong, their segments linear-oblong to linear-lanceolate; sori close to margin; spores pale brown, finely granular. July, August.

Rock fissures, on the shaded side.—European part: Urals; W. Siberia: Ob, Alt., Irt.; E. Siberia: Yen., Lena-Kol., Ang.-Say. **Gen. distr.:** Mong., Him., N. Am. Described from Siberia. Type in Leningrad.

Genus 22. **ADIANTUM** * L.

L. Gen. pl. (1737) 782.

Sori round, oblong, or linear, marginal; indusia false, membranous, representing a modified extension of marginal leaf lobe forming a membranous cover over the sori; spores with 3 stripes; stipes not jointed.

* From a, negative prefix, and diainein, to wet, i.e., unwetted, as water is readily shed from the leaves.

1. Leaves broadly oblong, bi- or tripinnatifid; ultimate segments rhombic-ovate, cuneate to cuneate-obovate at base 2. *A. capillus veneris* L.
 + Leaves broadly reniform, with pedate pinnae; ultimate segments oblong-rhombic 1. *A. pedatum* L.

1. *A. pedatum* L. Sp. pl. (1753) 1095; Ldb. Fl. Ross. IV, 526. — Ic. Gartenflora (1880) 220; Fedch. and Fler., Ill. opred. rast. Sib. 36; Kom. and Alis., Opred. I, Plate 14.

Perennial; rhizome slender, creeping, covered throughout with scales and roots; stipes castaneous-black, 20–40 cm long, shining, forked at the end, channeled ventrally and laterally; leaves broader than long, bipinnate; pinnules oblong-rhombic, pale green, pendent, short-stalked, incised-lobed at the margin; sterile lobes crenate to entire. July, August.

80 Broad-leaved and mixed woods on slopes, in humus. — Far East: Ze.-Bu., Uda, Uss. **Gen. distr.**: N. Am., Jap.-Ch. Described from Canada. Type in London.

2. *A. capillus veneris* L. Sp. pl. (1753) 1096; Ldb. Fl. Ross. IV, 527; Shmal'g. II, 687. — Ic.: Moore and Lindl. Brit. Ferns, tab. 45. — Exs.: HFR, No. 1749.

Perennial; rhizome creeping, clothed with narrow blackish scales; leaves broadly oblong, bi- or tripinnatifid, thin; stipes blackish-brown, thin, shining; ultimate segments borne on capillary stalks, cuneiform-ovate, asymmetric, entire on the sides, palmately dissected at apex; fertile lobes terminating in transverse linear-oblong sori; sterile lobes crenate or crenate-dentate. June, August.

Rock fissures, near oozing water, near waterfalls, on the banks of mountain streams, in caves, spreading most readily over calcareous formations, often on tuffs. — European part: Crim.; Caucasus: Cisc., Dag., W., E. and S. Transc., Tal.; Centr. Asia: Mtn. Turkm., Dzu.-Tarb., Pam.-Al., T. Sh. **Gen. distr.**: Atl. Eur., Med., N. Afr., As. Min. Described from S. Europe. Type in London.

Genus 23. *PTERIS* * L.

L. Hort. Cliff. (1737) 443; Sp. pl. (1753) 1073.

Sori linear, with marginal receptacles; veins anastomosing between the margins only in fertile leaves; margins of segments reflexed; indusia wanting; spores globose-tetrahedral, with 3 stripes; stipes not jointed; fertile leaves differing from the sterile.

The following fossil remnants have been found: *P. omissa* Heer in Tertiary layers (Cretaceous?) of Sakhalin at Mgachi; *P. oeningensis* Ung., *P. crenata* Web., *P. reflexa* Palib., and *P. blachnoides* Heer in the Pliocene of W. Transc. (Goderskii Pass); *P. pennaeformis* Heer in the Eocene of M. Dnp. (Putivl') and S. Transc. (Dzhul'fa); *Pteris* sp. in Tertiary layers of Balkh. (Ashutas peak) and in the Sarmatian stage of L. V. (Aleksandrova).

- 83 1. *P. cretica* L. Mantissa (1771) 130. — *P. pentaphylla* Willd. Sp. pl. V (1810) 362. — Ic. Luer. Farnpfl. f. 79; Lowe Ferns brit. and exot. III, tab. 43. Exs.: Sredinsky Herb. Crypt. ross., No. 20.

* From Greek *ptēris*, fem.



Plate III

1. *Cryptogramma Raddeana* Fom.: a) portion of sterile leaf; b) portion of fertile leaf; c) spores; d) scales.— 2. *Polypodium virginianum* L.: a) leaf; b) scale.— 3. *Pleurosoriopsis Makinoi* (Christ) Fom.: a) general aspect; b) underside of pinna; c) underside of pinnule; d) sporangia with spores.— 4. *Osmunda Claytoniana* L.: a) general aspect; b) segment of fertile leaf; c) and d) spores.— 5. *Botrychium robustum* (Rupr.) Underw.: a) portion of a leaf segment; b) portion of sporophyll; c) spores.— 6. *Salvinia natans* All.: a) general aspect; b) longitudinal and cross section of sporocarp; c) microsporangia.— 7. *Marsilea quadrifolia* L.: a) general aspect; b) sporocarp; c) sporocarp structure.— 8. *M. aegyptiaca* W.— 9. *Ophioglossum bucharicum* B.Fedtsch.— 10. *O. thermale* Kom.

Perennial; rhizome creeping, clothed with brown scales; leaves oblong, elongate, coriaceous; stipes long, triquetrous, glabrous; segments 3—9 pairs, opposite, subsessile, short-tapering toward base, at leaf apex decurrent; fertile segments narrower, entire; sterile segments lance-linear, acute, sharply serrate; spores brown, bluntly tetrahedral, with scattered narrow wings and wrinkled sides. July, August.

Damp shaded rocks, often in woods. — Caucasus: W. Transc., Tal.
Gen. distr.: Med., N. Persia. Described from Europe. Type in London.

Genus 24. **PTERIDIUM** * GLED.

In Boehmers Fl. Lips. (1750) 295, 723.;

Margins of fertile segments forming an uninterrupted strand, the sori occupying a marginal arch formed by vein anastomoses and covered by the revolute ciliate leaf margin; indusium double, the outer ciliate, the inner inconspicuous and rudimentary; rhizome creeping; leaves bi- or tripinnate; spores tetrahedral-globose.

1. **P. aquilinum** (L.) Kuhn in v. d. Deckens Reisen, III, Bot. v. Ost-Africa (1879) 11, Shmal'g. II, 687; Kryl., Fl. Zap. Sib. 1, 43. — *Pteris aquilina* L. Sp. pl. (1753) 1075; Ldb. Fl. Ross. IV, 524. — *Eupteris aquilina* Neum., Phytol. II (1845) 277.

Perennial; rhizome long, creeping horizontally at a given depth; leaves coriaceous, oval-deltoid, inclined, bi- or tripinnatifid, often tomentose beneath; stipes long, stout; pinnae opposite, lanceolate, the lower stalked; pinnules oblong-lanceolate, rarely elongate-linear (var. *caudatum* Hook.), broad at base, sessile, the lower more or less pinnately parted, the upper entire and almost confluent at base; sori uninterrupted, covered by the narrow revolute ciliate almost sinuate margin; spores brownish, granular-verrucose. July–September.

Coniferous and deciduous woods, coppices, on slopes, often in dry sandy soil, with preference for calcareous soils. — European part: from Lad.-Ilm., U. V., V. -Kama, down to Crimea in the south; Caucasus: Cisc., W. and E. Transc., Tal.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Ang.-Say., Dau.; Far East: Ze.-Bu., Uda, Uss., Sakh., Kamch.; Centr. Asia: Balkh. (Semipalatinsk, Akmolinsk). **Gen. distr.:** generally reported for the whole world except the polar region, steppes and deserts. Described from Europe. Type in London.

84 **Economic importance.** Young shoots are used in some countries for food (they are sold on the markets in Japan). The rhizome contains about 60 per cent of starch, lathering freely with water (used as soap in French villages); it has astringent properties and acts as a mild vermifuge; owing to its starch content it is used for making glue and for brewing beer; readily eaten by pigs, but poisonous to other livestock both fresh and as ensilage; excellent litter, improving the quality of manure. The leaves have a distinctive smell; they have rot-preventing properties, they repel insects, and are very effective as packing for preservation of fruit and vegetables. The ash contains potassium salts and is useful in glass and soap manufacture. If the plant becomes troublesome as a weed, it may be controlled by digging up the rhizomes.

* From Greek pteridion, diminutive form of pteris, wing, parabolically also a fern.

Subfamily 6. **Polypodiaceae** Diels

Sori dorsal or terminal; indusia wanting; stipes jointed; veins forking.

1. Leaves more or less covered with stellate hairs 26. **Cyclophorus** Desv.
- + Leaves glabrous 25. **Polypodium** L.

Genus 25. **POLYPODIUM*** L.

L. Gen. pl. (1737) 784.

Sori round or oblong, scattered or in rows; spores bilateral, with a single longitudinal stripe.

Polypodium sp. has been reported from Oligocene layers of M.Dnp. Reliability of the report doubtful.

1. Leaves pinnately divided, with rather long stipes; sori in two rows on lateral segments 2.
- + Leaves linear-lanceolate, entire; sori along the midrib 4. **P. lineare** Thunb.
2. Epiphytes growing on the bark of trees; leaves deltoid; segments long, gradually acuminate, with serrate margin 1. **P. serratum** (Willd.) Futo.
- + Plants growing in soil or on rocks, only exceptionally on trees; leaves oblong, lanceolate, or linear-lanceolate 3.
3. Scales on the rhizome light brown, rather broad, pointed; rhizome sweetish-tasting when broken; sori distant from the margin of segments 2. **P. vulgare** L.
- + Scales on the rhizome dark brown, with a blackish-brown shining median stripe; rhizome tasteless when broken; sori close to the margin of segments 3. **P. virginianum** L.

1. **P. serratum** (Willd.) Futo in Hedwigia, 44 (1905) 106—111; Fom. in Flora Cauc. crit. I (1912) 171.— **P. vulgare** f. *serratum* Willd. Sp. pl. V (1810) 173.— Ic.: Futo, l. c., tab. III.

Perennial; leaves rather large, oval or deltoid, mostly pointed, coriaceous, wilting in mid-summer and developing in fall; stipe the length of the frond, this 26—28 cm long and 12—15 cm broad; segments long, gradually acuminate, the margin crenate throughout; forks of the 3 or 4 secondary veins inclined forward; sori between the margin and midrib of segments; spores yellow, oblong-reniform, thinly and minutely verrucose. August, September.

Tree trunks and stumps, moss-covered rocks, and ruins.— European part: Crim.; Caucasus: W. Transc. **Gen. distr.:** Atlantic islands, Med.

Note. Interesting as a type of epiphytic fern.

2. **P. vulgare** L. Sp. pl. (1753) 1085; Ldb. Fl. Ross. IV, 508; Shmal'g. II, 686; Kryl., Fl. Zap. Sib. 45.— Ic.: Luer. Farnpfl. f. 66—67; Fedch. and Fler., Fl. Evrop. Ross., Figure 16.— Exs.: Sredinsky Herb. crypt. Ross., No. 1.

Perennial; rhizome sweet-tasting, creeping, often underground, densely clothed with brown scales; leaves in two ranks, oblong-lanceolate or narrower (var. *angustum* Haussm.), subcoriaceous, pinnatifid;

* From Greek polys, many, and podion, foot.

segments gradually diminishing in size from base to apex, linear-lanceolate, sometimes round-tipped (var. *rotundatum* Milde), commonly acute, entire or obscurely serrate, confluent toward base, the lowest pair sometimes auriculate at base (var. *auritum* Willd.); sori round, borne halfway between the margin and midrib; spores yellowish, covered with large and small tubercles. June, July.

Rocks and boulders, shaded stony slopes, rarely in soil in woods.—European part: Kar.-Lap., Lad.-Ilm., V.-Kama, U. Dnp., M. Dnp., V.-Don, Bes., N. Bl., Crim.; Caucasus: Cisc., Dag., E., W. and S. Transc., Tal.; Centr. Asia: Balkh. (Semipalatinsk), Dzu.-Tarb., T. Sh.; W. Siberia: Ob (Sosva, Tomsk), Alt., Irt. **Gen. distr.**: all Europe, Asia Minor, N. Am. Described from Europe. Type in London.

Note. The rhizome contains tannic and malic acids, saponin and glycyrrhizin; occasionally used in medicine against bronchitis. The sweetish taste accounts for the name "solodka" [sweet] in the Ukraine and "Engelsüsswurzel" or "Süssengelchen" in Germany.

3. **P. virginianum** L. Sp. pl. (1753) 1082; M. L. Fernald in Rhodora XXIV (1922) 125.—Ic.: Fom. in Fl. Sib. et Or. Extr. V, 185.

86 Perennial; rhizome 2—7 cm thick, insipid in taste, clothed with shining blackish-brown strongly pointed scales; stipes to 20 cm long; fronds oblong-lanceolate or often linear-lanceolate, deeply pinnatifid, the alternate segments linear or linear-lanceolate; sori close to the margin of segments; spores rather coarsely tuberculate. July, September. (Plate III, Figure 2 a—c).

Rocks and stony slopes, in mixed woods, occasionally on tree branches.—E. Siberia: Ang.-Say., Dau., Lena-Kol. (Olekma R.); Far East: Ze.-Bu., Uss., Uda. **Gen. distr.**: N. Am., E. Asia. Described from North America. Type in London.

4. **P. lineare** Thunb. Fl. Jap. (1784) 335.—*Pleopeltis ussuriensis* Rgl. et Maack in Rgl. Ussur. (1861) No. 175.—*P. lineare* var. *ussuriensis* Rgl. ex Kom. and Alis., *Opred. rast. Dal'n. Vost.* I (1931) 89.—Ic.: Fedch. and Fler., *Ill. opred. rast. Sib.* 33, Figure 39; Kom., l. c., tab. 15.—Exs. HFR, No. 1400.

Perennial; rhizome creeping, branched, clothed with reticulate brownish-black scales, 6—12 cm long and to 2 mm in diameter; leaves linear-lanceolate, short-stipitate, borne in 2 ranks, firm, subcoriaceous, to 10 cm long, 8—10 mm broad, the midrib prominent above; sori in 2 alternate rows along the midrib; spores reniform, rugose. June–September.

Rock fissures and tree branches.—W. Siberia: Alt.; Far East: Uss.; Centr. Asia: Dzu.-Tarb., T. Sh. **Gen. distr.**: Jap.-Ch. Described from Japan. Type in Uppsala.

Genus 26. **CYCLOPHORUS** * DESV.

Desv. in Berl. Mag. V (1811) 300.

Leaves nearly always undivided and entire, rather densely clothed with stellate hairs; lateral veins reticulately branched.

* From Greek *cyclos* or *kyclos*, circle, and *phoréo*, carry.

1. **C. lingua** (Thunb). Desv. Prodr. (1827) 224.—*Niphobolus lingua* Griesenh. Farngett. Niph. (1901) 156.—*Polypodium lingua* Sw. Syn. Fil. (1806) 29.—*Acrostichum lingua* Thunb. Fl. Jap. (1784) 336.—Ic. Schkuhr Crypt. Gew. tab. I; Kom. and Alis., Oprod., Plate 17.

Perennial; rhizome creeping; scales covering the rhizome oblong-lanceolate, pointed, long-fringed, blackish-brown at base, tightly appressed; leaves broadly lanceolate to oblong, 10–20 cm long and 2–5 cm broad; stipes 7–15 cm long; fronds coriaceous, sparsely covered above with stellate hairs, densely tomentose beneath with brown stellate hairs; sori 4–6 or in 1 or 2 rows in each areole, covering the whole leaf surface. June, September.

Rock fissures, often on the sunny side.—Far East: Uss. **Gen. distr. :** Jap.-Ch. Described from Japan. Type in Uppsala.

CHRY SODIUM Feé.

Fossilized remnants in Bl. (Voronovka near Voznesensk) in Eocene layers, Chr. Lanzeanum Gardn., a species distributed at the present time through the tropics of the Old and the New World, partly as a plant of mangrove thickets.

Family **GLEICHENIACEAE** R. BR.

Genus **GLEICHENIA*** SM.

In the USSR only in Cretaceous layers. At present this is a tropical genus, and some of its species abound in Japan.

Family **SCHIZAEACEAE** RCHB.

Genus **LYGODIUM**** SW.

In the USSR, *L. Gaudinii* Heer found in Oligocene layers of M. Dnp. (Ekaterinopol'e [Ekaterinopol']); *L. Kaulfussii* in Tertiary layers of Uss. (Rechnaya settlement). At the present time, tropical ferns, the twining rachis with indeterminate growth. The plant occurs in Japan. The stems are used in India for making ropes.

Family III. **OSMUNDACEAE** R. BR.†

Sporangia short-pedicelled, irregularly obovate, without annulus or with traces of it near the apex, opening into two valves; indusia wanting; spores tetrahedral-globose; leaves circinate in veneration; stipes not jointed.

* Named for the German botanist V. F. Gleichen (1717–1750) who conducted extensive studies in microscopy.

** From Greek *lygodes*, resembling a spruce twig, pliable.

† From Latin *os*, mouth, and *mundus*, clean, or *mundare*, to cleanse.

Genus 27. **OSMUNDA** L.

L. Gen. pl. ed. II (1742) 502.

Leaves pinnate or bipinnate, the sterile segments more strongly developed; fertile segments reduced and much contracted, densely covered on both sides with globose sporangia.

Fossilized: *O. Heeri* Gaud. in Paleocene layers of Uss. (Pos'et); *O. Torellii* Heer in Tertiary layers (Cretaceous?) of Sakhalin (Mgach); *O. sachalinensis* Krysch. in Tertiary layers of Sakhalin; *O. sp.* in Tertiary layers of W. Transc. (Kisatib) and Balkh. (Ashutas); *O. sp.* in the Eocene of E. Transc. (Dzhul'fa); *Osmundites kamyschinensis* Krassn. in the Paleocene of L. V. (Kamyshin).

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1. Fertile segments surrounded by the green segments, borne below the middle of the frond. 2. *O. Claytoniana* L.
- + Fertile and sterile fronds quite separate 2.
2. Pinnules ovate to oblong, exauriculate; main rachis and stipe of young leaves densely brown-tomentose, at length glabrate 1. *O. cinnamomea* L.
- + Pinnules oblong-lanceolate, apparently auriculate at base; main rachis and stipe glabrous 3. *O. regalis* L.

1. *O. cinnamomea* L. Sp. pl. (1753) 1066. — Ic.: Fedch. and Fler., Ill. opred. rast. Sib. 35, Figure 41; Kom. and Alis., Opred. I, Plate 18.

Perennial; rhizome short, oblique, rather stout; sterile leaves long-stipitate, oblong-lanceolate, pinnate, membranaceous; pinnae sessile, linear-oblong, pinnately divided; pinnules ovate or sometimes oblong, obtusish, entire, with forked veins; fertile fronds narrow, with longer stipe, densely tomentose, bipinnate; pinnules subcylindric, with crowded cinnamon-colored sporangia; of exceptional occurrence are green leaves with lower fertile segments yellow-colored. May, June.

Forming dense colonies in damp forest glades. — Far East: Sakh., Uss., Ze.-Bu., Kamch. **Gen. distr.:** N. Am., Jap.-Ch., Him. Described from Maryland in the U. S. A. Type in London.

2. *O. Claytoniana* L. Sp. pl. (1753) 1066. — *O. interrupta* Michx. Fl. Bor.-Am. II (1803) 273. — Ic.: Fom. in Fl. Sib. et Or. Extr. 196.

Perennial; rhizome strongly developed, short; fertile leaves resembling the sterile, all long-stipitate, 0.5–1.2 m long and 20 or more cm broad, oblong, membranaceous, twice pinnately parted; stipe and rachis at first densely covered with white or light brown tomentum, becoming glabrous; pinnae short-stalked, linear-lanceolate, pinnately parted; pinnules close to base, confluent, ovate, subentire, with forked veins; fertile leaves with longer stipes, bearing above the base 2–5 pairs of strongly pointed fertile pinnae with semicylindric pinnules; sporangia black. May, June. (Plate III, Figure 4 a–d).

Forest glades near streams and wooded gullies. — Far East: Uss. **Gen. distr.:** N. Am., Jap.-Ch., Him. Described from Virginia in the U. S. A. Type in London.

Note. The largest of all ferns of the USSR; ornamental.

3. *O. regalis* L. Sp. pl. (1753) 1065; Shmal'g. II, 685; Fom. in Fl. cauc. crit. (1912) 175. — *Struthiopteris regalis* Bernh. in Schrad. Journ. d. Bot. II (1800) 126. — Ic.: Moore-Lindl. Brit. Ferns tab. 110; Luer. Farnpfl. f. 174. — Exs.: Wirtgen Pterid. exs., No. 25.

89 Perennial; rhizome oblique, strong; leaves long, broadly ovate, subcoriaceous, glabrous, bipinnate; stipe channeled; pinnae subopposite, oblong, short-stalked; pinnules oblong, sometimes tapering toward apex and densely callous-toothed on the margin (Plumieri Milde), or oblong-lanceolate, obliquely truncate at base, subauriculate, entire or more or less crenate; upper segments fertile, gathered in a terminal panicle, contracted, narrowly linear, covered throughout with sori; veinlets of sterile segments entering into incisions between the teeth. May, June.

Alder groves; peat and forest bogs.—Caucasus: W. Transc. (coastal bogs of Abkhazia).^{*} Described from Europe. Type in London.

Order **Hydropteridinae**

Aquatic plants; spores of two kinds, macrospores in macrosporangia and microspores in microsporangia, both borne together in sporocarps.

Family IV. **SALVINIACEAE** BARTL.

Rhizome filiform, immersed, without roots; leaves in whorls of 3, of these two floating on the water surface, green, with a round or ovate petiole, the third immersed and strongly branched from base into filiform divisions; sporocarps 1-locular, several on apical branches of a common stalk, at the base of submersed leaves, some containing 1 or 2 macrosporangia, others 9–14 microsporangia.

Genus 28. **SALVINIA** ** MICHELI

Mich. Nova pl. gen. (1729) 107.

Stem floating, branched, filiform, with 2-ranked leaves floating on the surface; sporocarps globose.

Fossilized species of *Salvinia* occur frequently in Tertiary and Quaternary layers of the USSR: *S. glabra* Nikitin; *S. tuberculata* Nikitin in the middle Pliocene of V.-Don. (Krivobor'e, Uryv, Chertovitskoe); *S. Mildeana* Goepp. in Tertiary layers of N. Caucasus (Terek basin) and Ob (Tara); *S. natans* (L.) All. in Quaternary layers of V.-Don (Demshinsk, Podkletnoe, Gorokhovka); L.D. (Khopert-Endovskaya R.), L.V. (delta of Volga, bottom of Caspian Sea, Chernyi Yar, Nikol'skoe), and U.V. (Likhvin, Moscow); *S. Reussii* Ett. in Tertiary layers of Dzhilanchik in Ar.-Casp.; *S. sp.* in Saratian formations of Krynka R. in L. Don.

1. *S. natans* (L.) All. Fl. pedem. 2 (1785) 289; Ldb. Fl. Ross. IV, 494; Kryl., Fl. Zap. Sib. 46.—*Marsilea nutans* L. Sp. pl. (1753) 1099.—
20 Ic.: Fedch. and Fler., Fl. Evr. Ross. 20, Figure 19; Kom. and Alis., Opred., Plate 19.—Exs.: HFR, No. 247.

Leaves ovate-elliptic, obtuse, the upper surface covered with white bristly hairs, the lower surface with brown hairs; sporocarps in clusters of 4–8, at the base of the rootlike submersed leaves. August, September. (Plate III, Figure 6 a–d).

^{*} [General distribution not given in original text.]

^{**} Named for the Italian botanist Prof. A. Salvini (1633–1721).

Perennial; oxbow lakes and sluggish water courses, rarely in lakes.— European part: U. Dnp., M. Dnp., Bes., L. Don, L. V., Bl.; Caucasus: Cisc., E. Transc., Tal.; Centr. Asia: Ar.-Casp., Syr D.; W. Siberia: Ob (Tomsk), Irt.; Far East: Uss., Ze.-Bu. **Gen. distr.:** Centr. and S. Eur., Jap.-Ch., N. Am., India, N. Afr.

Genus **AZOLLA*** LAM.

Fossilized in Pliocene and Quaternary formations: *A. filiculoides* Lam. in Mindel-Rissian layers of V.-Don (Demshinsk in Usman District), in Riss-Würmian layers of L. V. in Chernyi Yar and Nikol'skoe; *A. sp.* of the section *Rhizosperma* A. Br. in the middle Pliocene of V.-Don (Krivobor'e, Chertovitskoe).

Family V. **MARSILEACEAE** R. BR.

Rhizome rooting in shallow muddy ground; leaves circinate in veneration; sporocarps 2- or 4-locular, borne on peduncles; macrospores and microspores contained in a common sporocarp.

1. Leaves consisting of a long petiole and 4 rounded-cuneate segments 30. **Marsilea** L.
- + Leaves filiform, pointed 29. **Pilularia** L.

Genus 29. **PILULARIA** ** L.

L. Sp. pl. (1753) 1100.

Leaves always bladeless; sporocarps solitary, subsessile.

Fossilized *P. sp.* (cfr. *americana* A. Br.) in the middle Pliocene of V.-Don (Krivobor'e).

1. **P. globulifera** L. Sp. pl. (1753) 1100.

Rhizome creeping; leaves to 10 cm long, filiform; sporocarps globose, tomentose, borne at the leaf base. July, August. (Plate IV, Figure 1).

Submerged edges of water bodies.— European part: possibly occurring in Podolia. Reported by Pallas for the Ural estuary (Gur'ev). **Gen. distr.:** S. Scand., Atl., Centr. and S. Eur. Described from Europe. Type in London.

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Genus 30. **MARSILEA** † L.

L. Gen. pl. (1737) 799.

Rhizome slender, creeping, branched; leaves slender-petioled, quadrifoliolate; sporocarps sessile or peduncled, ovaloid or subglobose, coriaceous; plantules with 1 or 2 filiform leaves.

1. Sporocarps ovaloid, 2 or 3 on a common peduncle 1. **M. quadrifolia** L.
- + Sporocarps solitary 2.

* A common American name.

** From Latin *pilula*, *pillule*, referring to the pill-shaped sporocarps.

† Named for L. Marsigli, Italian botanist (1658–1730), professor in Bologna and author of studies on fungi and Danubian riverside vegetation.

2. Peduncle many times as long as sporocarp; leaflets narrowly cuneate-ovate 3. *M. aegyptiaca* Willd.
 + Peduncle as long as or shorter than sporocarp; leaflets broadly cuneate-ovate 2. *M. strigosa* Willd.

1. *M. quadrifolia* L. Sp. pl. (1753) 1099; Ldb. Fl. Ross. IV, 494; Shmal'g. II, 692. — Ic. Luer ss. Farnpfl. 608, f. 187, 188.
 Perennial, glabrous, 8—20 cm tall; leaflets cuneate-orbicular, entire; sporocarps somewhat compressed, 2 or 3 on a common peduncle, attached to petiole, appressed-hairy becoming glabrous, spreading horizontally, with 2 short teeth at base. August-September. (Plate III, Figure 7 a—c).
 Stagnant waters and sporadically drying shallows. — European part: L. V.; Caucasus: W. and S. Transc., Tal.; Centr. Asia: Mtn. Turkm., Amu D. **Gen. distr.:** Atl., Centr. and S. Eur., S. and E. Asia, N. Am. Described from France. Type in London.

2. *M. strigosa* Willd. Sp. pl. V (1810) 540; Ldb. Fl. Ross. IV, 494; Shmal'g. II, 692. — Ic.: Fedch., Fl. Yugo-vost. I, Figure 24.
 Perennial, 5—10 cm tall, with hairs on petiole and leaf blade, becoming glabrous; leaflets cuneate, rounded at apex, entire; sporocarps solitary, declined, short-peduncled, attached to the base of petiole, cuneate-orbicular, compressed, strigose throughout, with 2 teeth at base, of these the upper somewhat more pointed. August, September.

Shallow river and lake overflows, and temporarily inundated places. — European part: L. V.; Caucasus: Tal.; Centr. Asia: Ar.-Casp., Balkh., Syr. D. Described from the southern part of the USSR. Type in Berlin.

3. *M. aegyptiaca* Willd. Sp. pl. V (1810) 540; Ldb. Fl. Ross. IV, 494; Shmal'g. II, 692.
 Perennial, small, 5—10 cm tall, with hairs on petiole and at the base of leaflets, at length glabrate; leaflets narrowly cuneate-obovate, often emarginate or incised; sporocarps obtusely 4-angled, with a dorsal groove, the peduncle many times the length of the body. August, September. (Plate III, Figure 8).

Temporarily inundated places, lagoons, and depressions among sands; resistant to drying out. — European part: L. V.; Centr. Asia: Balkh. (Zaisan on Baran Peninsula). **Gen. distr.:** E. Med. Described from Egypt. Type in Berlin.

Family **MARATTIACEAE**

Danaites Pawlowii Krassn. in the Paleocene of L. Don (Osinovka near Starobel'sk). The relationship of this fern to the genus *Danaea* is somewhat doubtful.

Family VI. **OPHIOGLOSSACEAE** R. BR.

Sporangia sessile, globose, distinct or connate, without annulus, opening by a transversal slit; indusium none; spores globose-tetrahedral; leaves straight (not circinate) in vernation, consisting of two portions, a leaflike

sterile outer portion and a fertile portion reduced to main rachis, contracted and often branched.

1. Sterile portion of the leaf simple; fertile portion a linear spike 31. *Ophioglossum* L.
- + Sterile portion of the leaf pinnately or bipinnately divided; fertile portion paniculately branched 32. *Botrychium* L.

Genus 31. **OPHIOGLOSSUM** * L.

Gen., ed. pl. II (1742), 503.

Sterile portion entire, somewhat fleshy, with anastomosing veins; fertile portion forming a linear spike; sporangia connate, in two ranks, opening into two valves by a transversal slit; spores 3-stripped; rhizome buried, short, the numerous fleshy unbranched roots capable of giving off adventitious shoots.

1. Leaves narrow, fleshy; plants 3—9 cm tall 3. *O. thermale* Kom.
- + Leaves broadly ovate, ovate-oblong, or lanceolate to linear-lanceolate, the blade rather thin 2.
2. Fertile portion of the blade arising from the middle of the sterile portion, this ovate or oblong, strongly narrowed toward base; spores tuberculate 1. *O. vulgatum* L.
- + Fertile portion arising at or near the base of the sterile portion . . . 3.
- 33 3. Sterile portion of the leaf oblong to oblong-lanceolate, obtusish; stalked spiciform fertile portion arising at the base of the plant 2. *O. bucharicum* O. et B. Fedtsch.
- + Sterile portion of the leaf lanceolate to linear-lanceolate; stalked spiciform fertile portion arising slightly above the base of the sterile portion; spores smooth 4. *O. lusitanicum* L.

1. *O. vulgatum* L. Sp. pl. (1753) 1062; Ldb. Fl. Ross. IV, 504.— Ic.: Fedch. and Fler., Ill. opred. rast. Sib. 35, Figure 42; Luer. Farnpfl. f. 175; Moore Lindl. Brit. Ferns tab. 51.— Exs.: HFR, No. 48.

Perennial; rhizome short, with long roots; sterile portion of the leaf ovate to ovate-oblong, rather fleshy, strongly narrowed and curved at base, sometimes consisting of 2 or 3 narrowly oblong blades (var. *polyphyllum* A. Br.), the network of areoles commonly obscure or, in Kamchatka, plants rather pronounced (var. *alaskanum* Christ); fertile portion stalked, the long spike projecting above the sterile portion; spores tuberculate. July, August.

Wet forest glades and thickets.— European part: Kar. -Lap., Lad. -Ilm., U. Dnp., M. Dnp., U. V., V. -Kama, V. -Don, Crim.; Caucasus: Cisc., W. and E. Transc., Tal.; W. Siberia: Ob (Tobol'sk), Tomsk; Far East; Kamch. **Gen. distr.:** Scand., Atl. and Centr. Eur., N. Afr. Described from Europe. Type in London.

2. *O. bucharicum* B. et O. Fedtsch. in AHP XXXVIII (1924) 29.— *O. vulgatum* var. *bucharicum* O. et B. Fedtsch., Rast. Turk. (1915) 20.

Rhizome short, with wide-spreading roots; sterile portion of the leaf oblong-lanceolate, obtuse or slightly pointed; fertile spike on a very short

* From Greek *ophis*, serpent, and *glossa*, tongue.

stalk, arising near the base of sterile portion or well below the middle of the plant, the blade with a distinct midrib; sterile blades 1 or 2. May-October. (Plate III, Figure 9).

Saline riverside lowlands.— Centr. Asia: Pam.-Al. (Pyandzh R.).
Gen. distr.: Endemic. Described from Bukhara (Kabadian). Type in Leningrad.

3. **O. thermale** Kom. in Fedde Repert. XVIII (1914) 84.— Ic.: Kom., Fl. Kamch. 1 (1927) 72, tab. II.— *O. vulgatum* var. *thermale* C. Christens in Hulten Fl. of Kamtch. (1927) 45.

Plants 4—13 cm long; rhizome short, cylindric; sterile leaves ovate, ovate-oblong, or rarely lanceolate, mostly obtuse, cuneate at base, petiolate, 3—8 cm long, 5—17 mm broad, the petiole 2—2.5 cm long, the blade thick, obscurely veined, 3 veins visible on dried specimens; fertile spike 0.5—3 cm long, pointed or obtuse, with 8—24 pairs of sporangia; spores to 30 mm [?], whitish, almost smooth. August. (Plate III, Figure 10).

Meadows near hot springs.— Far East: Kamch. **Gen. distr.:** Endemic. Described from Kamchatka. Type in Leningrad.

4. **O. lusitanicum** L. Sp. pl. (1753) 1063.— *O. vulgatum* var. *lusitanicum* Hook. et Arn. Brit. Fl. ed. VII, 593.— *O. vulgatum* var. *angustifolium* Hook. Brit. Ferns tab. 47.— Ic.: Moore-Lindl. Brit. Ferns, tab. 51 C.; Luer ss.— Figure 177 et 178.

Sterile leaves lanceolate or lance-linear, cuneately narrowed from the middle to base, the epidermis cells straight; spike linear, the long stalk arising nearly at the base of the sterile portion; spores smooth.

Stony soil.— Caucasus: W. Transc. (Abkhazia).— **Gen. distr.:** Atl. Eur., Med. Described from Europe. Type in London.

Genus 32. **BOTRYCHIUM** * SW.

Sw. in Schrad. Journ. bot. 8 (1800), 110.

Sterile portion of the leaf pinnate, pinnatifid or decompose; sporangia of fertile leaves distinct, borne in two ranks in compound spikes or panicles; spores pale, globose-tetrahedral, 3-striped.

- 1. Sterile blade broad, deltoid-triangular or deltoid-cordate in outline, twice or thrice pinnatifid. 2.
- + Sterile blade oblong, oblong-cordate, simply pinnate, sometimes lobed or incised. 4.
- 2. Blade glabrous, membranaceous, the ultimate segments sharply toothed. 8. **B. virginianum** (XL.) Sw.
- + Blade with scattered white hairs, fleshy 3.
- 3. Ultimate segments irregularly and remotely crenate 6. **B. multifidum** (Gmel.) Rupr.
- + Ultimate segments more finely crenate-dentate, the segment margins appearing crisp-dentate 7. **B. robustum** Und.
- 4. Sterile blade petiolate, from well below the middle of the plant, often nearly at base, entire or irregularly lobed 3. **B. simplex** Hitchcock.
- + Sterile blade sessile or nearly so or short-petioled from the middle or above the middle of the plant 5.

* From Greek botrichion, modified form of botrys, cluster or bunch of grapes.



Plate IV

1. *Pilularia globulifera* L.—2. *Asplenium samarkandense* Koss.—3. *A. Sarelli* Hook var. *altajense* Kom.: a) undersurface of leaves; b) undersurface of a segment lobe; c) upper surface of same; d) spores.—4. *A. pseudofontanum* Koss.: a) leaf; b) spores.—5. *A. incisum* Thunb.: a) leaf; b) undersurface of a segment lobe; c) spore.—6. *A. anogrammoides* Christ.: a) leaf; b) undersurface of a leaf segment; c) spores.—7. *Anogramma leptophylla* Link.: a) general aspect; b) undersurface of a leaf segment.—8. *Cheilanthes Kuhnii* Milde: a) leaf; b) undersurface of a leaf segment; c) spores.—9. *Botrychium simplex* Hitchcock.—10. *B. ramosum* (Roth) Asch.—11. *B. multifidum* (Gmel.) Rupr.—12. *B. lanceolatum* Angstr.

5. Fertile portion long-stalked; segments of sterile blade crescent-shaped, lunate-rhombic, sometimes fan-shaped 5. *B. lunaria* (L.) Sw.
- + Fertile portion short-stalked, raised little above the sterile blade 6.
6. Sterile blade oblong or triangular-oblong in outline, with 3 or 4 or sometimes 5 pairs of subopposite irregularly and unequally lobed obtuse segments, the lobes obscurely veined 4. *B. ramosum* (Roth) Aschers.
- + Sterile blade different. 7.
7. Sterile blade cordate-ovate in outline, with a very pronounced midrib and fan-shaped venation in the ovate or ovate-incised segments 1. *B. boreale* (Fr.) Milde.
- + Sterile blade ovate to triangular-ovate in outline, with a distinct midrib and secondary veins not merely in the central part of the blade but also in the oblong to oblong-lanceolate or linear-lanceolate segments 2. *B. lanceolatum* Angstr.

1. *B. boreale* (Fr.) Milde Bot. Ztg. (1857) 478, 800.—*B. lunaria* var. *boreale* Fr. Herb. norm. 16, No. 85.—*B. crassinervium* Rupr. in Milde Nova Acta Acad. Leop., vol. 26 (1858) 763.—Ic.: Fedch. and Fler., Ill. opred. rast. Sib., pp. 37—38, Figures 44—46; H. Christ Farnkr. d. Erde, p. 365, Figure 1147.

Perennial, 10—18 cm long; rhizome straight, inflated; sterile blade fleshy, cordate-ovate, pointed at apex, pinnately divided; lower segments cordate-ovate, entire or obtusely flabellately lobed, the lower lobes ovate; upper segments ovate; veins of segments and of lobes fan-shaped, simple or forked; fertile panicle pinnate, from the base of the sterile blade; spores globose-tetrahedral, granular. July, August.

Grassy slopes and wet meadows of the forest tundra — European part: Kar. -Lap.; W. Siberia: Ob; E. Siberia: Yen.; Far East: Uss., Kamch. **Gen. distr.**: Eur., N. Am., Alaska. Described from Europe.

- 98 2. *B. lanceolatum* Angstr. Bot. Not. (1854) 68.—Ic.: Britt. u. Br. p. 6, fig. 13; Lueress, Farnpfl., fig. 179.

Perennial, 7—20 cm long; sterile blade submembranaceous, to 5 cm long, sessile, ovate to triangular-ovate in outline, pinnatifid, the narrowly lanceolate to oblong-lanceolate pinnae dissected into linear lobes; pinnae 3—5 pairs, with a distinct midrib and fan-shaped lateral veins; segments upright or spreading; fruiting panicle twice pinnately parted; spores globose-tetrahedral, irregularly and coarsely granular. (Plate IV, Figure 12).

Meadows and forest margins.—European part: Kar. -Lap., Lad. -Ilm., V. -Kama; W. Siberia: Ob; E. Siberia: Yen.; Far East: Ze. -Bu., Uss., Kamch., Sakh. **Gen. distr.**: Eur., Asia, N. Am., Arctic. Described from Scandinavia.

3. *B. simplex* Hitchcock in Amer. Journ. Sc. VI (1823) 103.—Ic.: Lueress, l. c., p. 578, fig. 181; Britt. and Br. 1, l. c., p. 3, fig. 4.—Exs.: Rabenh. 8.

Perennial, to 8—15 cm long; leaves yellowish-green; petiole 0.5—2.5 cm long, surrounded by sheaths of preceding year's leaves; sterile blade orbicular to obovate, often unevenly lobed, the terminal lobe large, rounded;

sterile blades sometimes 2-4, all petiolate, from the base of the plant; fertile portion long-stalked. July-August. (Plate IV, Figure 9).

Meadows.— European part: Lad. -Ilm. Described from North America.

4. **B. ramosum** Aschers. Fl. Brand. 1 (1864) 906.— *Osmunda ramosa* Roth Tent. Fl. Germ. 1 (1788) 444.— *B. matricariaefolium* A. Br. in Döll. Rhein. Fl. (1843) 24.— Ic.: Luer ss, l. c., p. 571, fig. 180.

Perennial, 10—20 cm high, the lower part often reddish; sterile blade oblong to triangular-oblong, divided into 3—5 pairs of opposite irregularly pinnatifid pinnae, the uppermost abbreviated and confluent; fertile panicle twice or thrice pinnately divided, raised on a short stalk above the sterile portion. (Plate IV, Figure 10).

European part: Lad. -Ilm. (There is a possibility that it may yet be found in Volhynia). **Gen. distr.:** Europe. Described from Central Europe.

5. **B. lunaria** (L.) Sw. Schrad. Journ. (1800) 110.— *Osmunda Lunaria* L. Sp. pl. (1753) 1064.— Ic.: Milde, Nov. Act. XXVI, 2 tab. 47, 48; Moore-Lindl. Brit. Ferns tab. 51 A.; Luer ss. Farnpfl. fig. 176; Bitter in Engl. u. Prantl., l. c., p. 457, fig. 259, B. D.; Fedch. and Fler., Fl. Evrop. Rossii, p. 19, Figure 18.

99 Perennial; rhizome creeping; sterile blade oblong, sometimes very small (var. *alpinum* Kryl.), fleshy, rounded at apex, embracing at the middle the stalk of the fertile portion, pinnately cleft, commonly with several pairs of alternate reniform-rhomboid or crescent-shaped pinnae, these entire (var. *normale* Roep.) or obtusely toothed and somewhat incised (var. *subincisum* Roep.), sometimes flabellately arranged and then crenate and with pinnately divided fertile panicle (var. *onondagense* Clute); fertile portion stalked, from the sheath of the sterile blade; fruiting panicle narrow, twice or thrice pinnate, rarely simply pinnate with few pinnae, 3 to 5—6 cm long; mostly a single leaf produced each year from the rhizome. July-August.

Meadows, coppices, and woods.— European part: Kar. -Lap., Lad. -Ilm., U. V., V. -Kama, U. Dnp., M. -Dnp., V. -Don, Crim.; Caucasus: Gr. Cauc., Dag., Tal.; W. Siberia: Ob, Irt., Alt.; E. Siberia: Yen., Dau., Ang. -Say., Lena-Kol.; Far East: Kamch., Sakh., Uss.; Centr. Asia: Dzu. -Tarb., T. Sh. **Gen. distr.:** all Europe, W. and N. Asia, Him.; N. Am., S. Am., Aust. Described from Europe. Type in London.

6. **B. multifidum** (Gmel.) Rupr. Beitr. XI (1859) 40.— *B. Matricariae* Sprend. Syst. veget. IV (1825) 23.— *Osmunda matricariae* Schrank Baier. Fl. II (1789) 419.— *O. multifida* Gmel. Nov. Comm. Acad. Petr. XII (1768) 517, t. 11, f. 1.— Ic.: Luer ss, l. c., p. 5, fig. 11; Fedch. and Fler., Ill. opred. rast. Sib., Figure 47.

Perennial; rhizome short; roots clustered; plants 8—32 cm high, with 1 or 2 petiolate fertile blades from the base or lower part of a common petiole; one of the blades of the preceding year yellowish-green, wilting, the other vigorous, dark green, at first sparsely hairy, becoming glabrous, broadly triangular, 2—7 cm long and 3—10 cm broad, thick, fleshy, twice or thrice pinnate, with 2—4 or rarely more pairs of pinnae, these ovate in outline, bipinnatifid or incised, stalked; pinnules ovate, asymmetric at base, often cleft into similar ovate asymmetric segments; ultimate segments irregularly and coarsely crenate, the upper ones confluent; fruiting panicle

ovate or triangular-ovate, twice or thrice branched; spores globose-tetrahedral, finely granular. July-August. (Plate IV, Figure 11).

Light dry woods and wood margins.— European part: Lad.-Ilm., U. Dnp., M. Dnp., V.-Don; W. Siberia: Irt., Alt. **Gen. distr.:** Eur., N. Asia, Him., N. Am., S. Am. (Patagonia), Australia. Described from Denmark.

7. **B. robustum** (Rupr.) Und. Bull. Torr. Bot. Club (1903) 51.—
B. rutaefolium var. robustum Rupr. in Milde, Nov. Act. Acad.
100 Leop. XXVI (1858) 763, p. 55, fig. 9.— B. multifidum Rupr. var.
robustum.— C. Christens in E. Hulten Fl. of Kamtch. 1 (1927) 48.—
Ic.: Kom. Fl. Kamtsch. 1, tab. II. Fom. Fl. Sib. et Or. Extr., p. 213.
A. B. C. D.

Perennial, 15–25 cm high, covered with scattered or here and there crowded white hairs; sterile blade broadly cordate-triangular in outline, tripinnatifid, to 10 cm long, 13 cm broad; petiole stout, about as long as blade; pinnae oblong to oblong-lanceolate, divided into oblong or oblong-lanceolate segments; ultimate segments or lobes ovate, denticulate-crenulate, the lateral veins in the lobes forked; fertile panicle thrice branched, effuse, the stout stalk exceeding the entire sterile portion; sporangia sessile; spores globose-tetrahedral, finely granular. July-September. (Plate III, Figure 5 a–c).

Meadows and light woods.— Far East: Ze.-Bu., Uss., Kamch., Sakh.* Described from Kamchatka. Type in Leningrad.

8. **B. virginianum** (L.) Sw. Schrad. Journ. (1800) 111.— *Osmunda virginiana* L. sp. pl., (1753) 1064.— Ic.: Milde Nov. Act., XXVI, 2, tab. 53, fig. 201; Luerst., l. c., p. 589, fig. 183; Fedch. and Fler., Ill. opred. rast. Sib., Figure 48.

Perennial, averaging 20–45 cm in height; leaf petiole long, sparsely covered with long hairs; sterile blade pentagonal-cordate or deltoid-cordate in outline, thrice pinnately divided; lower pinnae triangular-ovate, the upper oblong; pinnules lanceolate to linear-lanceolate; ultimate segments small, ovate or oblong, sharply toothed; fertile panicle long-stalked, twice or thrice pinnately branched; spores globose-tetrahedral, coarsely granular. July-August.

Forest glades and coppices.— European part: Lad.-Ilm., U. Dnp., M. Dnp., U. V., V.-Kama, V.-Don; W. Siberia: Ob, Alt.; E. Siberia: Yen. **Gen. distr.:** Scand., Centr. Eur., Jap.-Ch., N. Am. Described from North America.

Class II. Equisetales**

Stem clearly monopodial; leaves in regular nodal whorls; sporangia formed by modified umbelliform leaves borne at the end of the stem in compact spikes; sperm cells multiciliate.

* [General distribution not given in the original.]

** Arranged by M. M. Il'in.

Genus 33. **EQUISETUM** * L.

L. gen. pl.* (1737) 322.

Perennials with creeping branched rhizomes; stems with whorled branches, rarely simple, the internodes hollow; leaves united at base into a nodal ring, the growing zone of internodes covered by leaves containing much sugar; leaf tips narrowly dentiform; sporangia paired, on the inner side of sporophylls; spores all alike, with two elaters; prothallia dioecious.

Fossilized in Tertiary and Quaternary formations: branched, *E. cfr. limosellum* Heer, in Sarmatian layers of Bl. (Orekhov); *E. sp.* in Tertiary formations of Kamch., An., and Uss., in the middle Pliocene of V.-Don (Uryv, Ivintsa, Voronezh), and in Mindel-Rissian layers of V.-Don (Voronezh); *E. limosum* L. (= *E. heleocharis*) in Quaternary layers of U. Dnp. (Timoshkovichi) and V.-Kama (Galich).

1. Fertile spring-produced stems pale-colored or brownish, promptly wilting, readily distinguishable from later produced green stems** 2.
- + Fertile stems as above, developing only in spring, but after sporulation giving rise to green branches, whereupon resembling sterile stems 3.
- + All stems alike, green; fruiting cones developing much later 4.
2. Fertile stems stout, the large fruiting cone 3—8 cm long; stem sheaths with 20—30 lance-subulate teeth 2. ***E. majus*** Gars.
- + Fertile stems more slender; fruiting cones 15—35 cm long; stem sheaths with 8—10 or up to 16 lanceolate acute teeth 1. ***E. arvense*** L.
3. Sheaths of fertile stems 1.5—3.5 cm long, their teeth fulvous to brown, united throughout into lobes of 2—5 teeth; main branches forking 4. ***E. silvaticum*** L.
- + Sheaths of fertile stems 1—1.5 or up to 1.7 cm long, their brownish teeth only exceptionally fused; branches all simple 3. ***E. pratense*** Ehrh.
4. Stems not rigid, dying off in fall; stomata scattered and superficial; cone blunt (Section *Euequisetum* Sad.) 5.
- + Stems rigid, perennial, evergreen; stomata in regular rows, immersed below the epidermal layer; cone pointed. (Section *Hippochaete* Milde) 10.
- 102 5. Branches always forking; ridges of the stem flat at the top, the sharp edges remotely aculeate 4. ***E. silvaticum*** L.
- + Branches mostly simple; ridges different 6.
6. Ridges of the upper part of the stem prickly-papillose; branches numerous in regular nodes, arched-recurved, without cavities 3. ***E. pratense*** Ehrh.
- + Stem ridges without such papillae 7.
7. Teeth of sheaths broadly lanceolate 8.
- + Teeth of sheaths lance-subulate; stems smooth 9.

* The name *Equisetum* is derived from the words *equus*, horse, and *seta*, bristle, implying tail; the name was first used by Pliny for a slender-branched species of *Equisetum* reminiscent of a horse's tail.

** If only green sterile stems are present, pass right over to stage 4.

8. Teeth of sheaths fused in 2's or 3's; branches without cavities, with very sharp ridges, devoid of crossbands, the tips of teeth spreading; green stems without cones 1. *E. arvense* L.
- + Teeth not fused; branches often wanting, with crossbands and cavities; tips of teeth not spreading 5. *E. palustre* L.
- + Teeth mostly fused in 2's or 3's; branches with or rarely without a cavity, reaching the upper part or at least the middle of the stem, devoid of crossbands, the teeth mostly pointed; stems terminating in cones 7. *E. litorale* Kühlenwein.
9. Stem whitish or pale green; branches in dense regular whorls; ridges with a deep groove 2. *E. majus* Gars.
- + Stem normally green, mostly simple, rarely with solitary or few branches, the ridges not grooved 6. *E. heleocharis* Ehrh.
10. Grayish-green plants, mostly branched in lower part; sheaths rather pale, elongated, obconical, their teeth tapering into caducous lance-subulate scarious tips; plants growing in dry places 8. *E. ramosissimum* Desf.
- + Plants with different characters; branches none or few and solitary; sheaths often with a black crossband 11.
11. Teeth prolonged into a lance-linear tip, papillose on the back, white-toothed on the margin (Caucasus) 11. *E. trachyodon* A. Br.
- + Teeth without papillae or teeth 12.
12. Stems rather numerous, rather short, slender; sheaths commonly with 3-6 teeth 13.
- + Larger plants; sheaths with more numerous teeth 14.
13. Stems 0.5-0.75 mm in diameter; central cavity [centrum] none; peripheral cavities 3, hexagonal-stellate; teeth of sheaths 3, gradually tapering and pointed 13. *E. scirpoides* Michx.
- + Stems 0.75-2 mm in diameter, with centrum and peripheral cavities; teeth of sheaths 4-6, abruptly subulate-tipped 12. *E. variegatum* Schleich.
14. Teeth of sheaths promptly caducous, persistent only on terminal sheath 9. *E. hiemale* L.
- + Teeth of sheaths narrow, long, delicate, blackish-brown, white-margined, here and there readily caducous . . . 10. *E. Komarovi* Iljin.

Section 1. **EUEQUISETUM** Sad. in Nat. Pflanzf. 1, 4 (1902) 545.—*Equiseta phaneropora* Milde (characters in the key).

Subsection 1. **EQUISETA HETEROPHYADICA** A. Br. in Flora (1839)
305. Fertile stems differing from the sterile: yellowish or brownish spring stems bearing fruiting cones; green summer stems sterile.

Series 1. **Equiseta ametabola** (vernalia) A. Br. in Flora (1839) 305.—*E. anemopora* Milde. Fertile stems dying after fruiting.

1. *E. arvense* L. Sp. pl. (1753) 1061; Ldb. Fl. Ross. IV, 486; Kryl., Fl. Zap. Sib. 51.—*E. arcticum* Rupr. Distr. crypt. (1845) 21.—Ic.: Lindman Bild. ur Nord. Fl. II (1905) tab. 515.—Exs.: Baenitz Herb. Eur., No. 1729; HFR, No. 1700 (var. *campestre*).

Perennial; rhizome deep-buried, blackish, with scattered blackish tubers; stems 10—50 cm long; spring-produced fruiting stems brownish, succulent, promptly wilting; summer-produced stems green, sterile or exceptionally fertile (var. *campestre* Milde), branched, in the tundra forms no main stem developing (var. *arcticum* Rupr.), the narrow centrum surrounded by several narrower cavities; branches in whorls all the way up the stem or rarely confined to the lower part (var. *boreale* Milde), mostly ascending, simple, without cavities; teeth of branch sheaths green, with long mostly spreading tips; cone blunt. March-May. (Plate V, Figure 2 a—b).

Arable fields and fallows, sandy coasts, meadows, etc. In all regions of the USSR. **Gen. distr.**: ubiquitous in the Temperate Zone. Described from Europe. Type in London.

Economic importance. Used as feed for horses, but considered by some to be harmful to cattle by producing a sickness called "equisetosis" while any such effect is denied by others. It is possible that "equisetosis" is brought about by other horsetail species. *Equisetum arvense* is a burdensome weed of cereal fields, especially in the forest zone. It is also known as a medicinal plant (diuretic). The underground tubers are rich in starch and are gathered in some places for food, while the fruiting stems are eaten on account of their sugar content under the name "pestyshki" [pest, pestle] or "tolkachiki" [tolkach, pusher, pounder]. The plant treated with alum imparts a grayish-yellow color to wool.

2. *E. majus* Gars. Descript., Vert. et Usag. (1767) 166.—*E. maximum* Lam. Fl. Franc. 1 (1778) 7.—*E. telmateja* Ehrh. in Hannov. Mag. 18 Stück (1783) 287; Ldb. Fl. Ross. IV, 485.—*E. transcaasicum* Fisch. mscrpt. sec. Milde Verhandl. d. Zool. Bot. Ges., Wien (1862) 515.—*lc.*: Hook Brit. Ferns tab. 5, 88.—*Exs.*: HFR, No. 1050.

Perennial; rhizome deep-buried; stems 15—100 cm long; spring-produced stems stout, unbranched, brownish, the approximate sheaths with 20—30 lance-subulate teeth; summer-produced stems sterile, pale green, branched, the large centrum surrounded by narrow vallicular cavities; branches firm, ascending, simple; teeth of sheaths on fruiting stems 20—40, tightly appressed, with soft subcapillary tips; cone large, blunt. (Plate V, Figure 1 a—c).

Beech and oak woods, forest margins, meadows, and banks of streams. In fertile forest soils large specimens are produced; in sandy and stony soils the development is restricted to low undergrowth. European part: Bl., Crim.; Caucasus: Cisc., Dag., W. and E. Transc., Tal. **Gen. distr.**: S. Scand., Centr. and Atl. Eur., Med., Bal.-As. Min., Arm.-Kurd., N. Am. Described from Europe (vicinity of Paris).

Series 2. *Equiseta metabola* (subvernalia) A. Br. l.c. (= *E. stichopora* Milde). Spring-produced fruiting stems developing green shoots after ripening of the spores and acquiring the shape of summer shoots.

3. *E. pratense* Ehrh. Hannover Mag. 9 (1784) 138; Ldb. Fl. Ross. IV, 488; Kryl., Fl. Zap. Sib. I, 52.—*E. Umbrosum* I. G. Meyer in Willd.

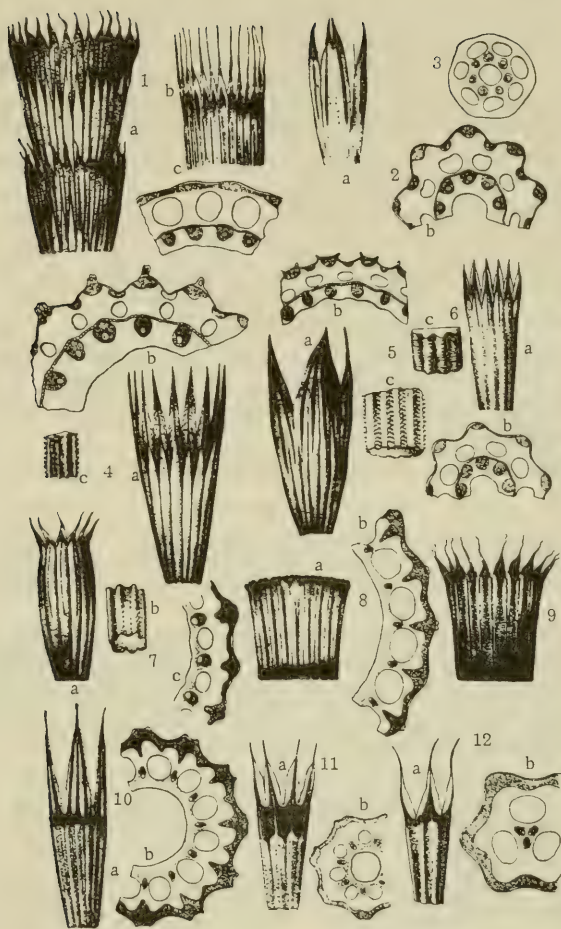


Plate V

1. *Equisetum majus* Gars.: a) nodal sheath of fruiting stem; b) nodal sheath of sterile stem; c) cross section of stem.—2. *E. arvense* L.: a) nodal sheath; b) cross section of stem.—3. *E. litorale* Kuhlw.: cross section of stem.—4. *E. pratense* Ehrh.: a) nodal sheath; b) cross section of stem; c) structure of stem apex.—5. *E. silvaticum* L.: a) nodal sheath; b) cross section of stem; c) structure of stem apex.—6. *E. palustre* L.: a) nodal sheath; b) cross section of stem; c) structure of branch and stem apex.—7. *E. ramosissimum* Desf.: a) nodal sheath; b) structure of branch; c) cross section of stem.—8. *E. hiemale* L.: a) nodal sheath; b) cross section of stem.—9. *E. Komarovii* Iljin, nodal sheath.—10. *E. trachyodon* A.Br.: a) nodal sheath; b) cross section of stem.—11. *E. variegatum* Schleich.: a) nodal sheath; b) cross section of stem.—12. *E. scirpoides* Michx.: a) nodal sheath; b) cross section of stem.

Enum. pl. horti Berol. (1809) 1065.— *E. pictum* Fisch. in Herb. Petrop. sec. Milde.— Ic.: Hook. Brit. Ferns tab. 59.— Exs.: H. exs. austro-hung., No. 2302; HFR, No. 300.

- 107 Perennial, tuberless; stems 10–30 cm long; spring-produced stems fruiting, more or less succulent, pale, becoming green upon maturation of spores and developing simple firm spreading or arched-recurved branches and green sterile stems with similar branches, densely beset in upper part with pointed papillae (readily visible with a magnifying glass), with a large centrum and numerous small peripheral cavities; teeth of nodal sheaths broadly lanceolate, those of ramal sheaths ovate, acute; cones blunt. May–July. (Plate V, Figure 4 a–c).

Shady woods, thickets, and meadows.— Arctic: Arc. Eur., Arc. Sib., Chuk.; European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., V.-Kama, U. Dnp., M. Dnp., V.-Don, Transv., Bl., L. Don, Crim.; Caucasus: Cisc.; Centr. Asia: Ar.-Casp., Balkh., T. Sh.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Kamch., Okh., Ze.-Bu., Uda, Uss., Sakh. **Gen. distr.:** Scand., Centr. and Atl. Eur., N. Bal.-As. Min., N. Dzu.-Kash., N. Mong., N. Jap.-Ch., N. Am. Described from Europe. Type in Geneva (De Candolle's herbarium).

Economic importance. Used as feed for horses, especially in tundra areas of Siberia.

4. *E. silvaticum* L. Sp. pl. (1753) 1061; Ldb. Fl. Ross. IV, 487; Kryl., Fl. Zap. Sib. 1, 53.— Ic.: Hook. Brit. Ferns tab. 61.— Exs.: Fl. exs. Austro-hung., No. 2705; HFR, No. 1698.

Perennial; rhizome slender, blackish-brown; stems 25–50 cm long; spring-produced fruiting stems, with large ferruginous-brown campanulate nodal sheaths, simple, giving rise to green branches upon ripening of spores; summer-produced stems green, the centrum large, the ridges flat at the top; with sharp prickles on the edges; branches arched-recurved, without centrum, forking, sometimes but half as thick as the typical and subhorizontal (var. *capillare* Milde); teeth of ramal sheaths tapering to a point, those of primary sheaths ferruginous-brown, united in 2's to 5's. April–June. (Plate V, Figure 5 a–c).

Woods, glades, thickets, mostly in rather dry soil.— Arctic: Arc. Eur., Nov. Z., Arc. Sib.; European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., V.-Kama, U. Dnp., M. Dnp., V.-Don, Transv., Bl.; Caucasus: Cisc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Ze.-Bu., Uss., Uda, Sakh., Okh., Kamch.; Centr. Asia: Ar.-Casp., Balkh. **Gen. distr.:** Arctic region (Greenland), Scand., Atl. and Centr. Eur., W. Bal.-As. Min., N. Dzu.-Kash., N. Mong., Jap.-Ch., N. Am. Described from N. Europe. Type in London.

- 108 **Economic importance.** Poisonous to guinea pigs, but acceptable as feed for horses. According to Slotvsov, the young shoots are used for food. Dyes wool a grayish-yellow color. Used in popular medicine as diuretic and astringent.

Subsection 2. *EQUISETA HOMOPHYADICA* or *AESTIVALIA* A.Br.
in Flora (1839) 305. Fertile and sterile stems alike.

5. *E. palustre* L. Sp. pl. (1753) 1061; Ldb. Fl. Ross. IV, 488; Kryl., Fl. Zap. Sib. 54; Turz. Fl. baic-dah. II, 355; Fom. in Fl. cauc. crit. I, 1, 200; Shmal'g, II, 680.— Ic.: Lindman Bild. ur Nord. Fl. II (1905) tab. 514.— Exs.: Fl. Hung. exsic., No. 640; HFR, No. 1699.

Perennial; rhizome often with tubers; stems 15–50 cm long, mostly branched, rarely simple, with a very narrow centrum and several smaller vallecular cavities; branches mostly ascending and arcuately incurved, with a narrow cavity; teeth of sheaths triangular-ovate, brownish at the tips, white hyaline-margined, on the main stem broadly lanceolate; cone blunt, solitary or cones produced at the ends of lateral branches (var. *polystachyum* Weigel). June–September. (Plate V, Figure 6 a–c).

Swamps, wet meadows, and shores.— Arctic: An.; European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., V.-Kama, U. and M. Dnp., V.-Don, Transv., Bl., L. Don, L. V.; Caucasus: Cisc., Dag., W., E. and S. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Lena-Kol, Ang.-Say., Dau.; Far East: Kamch., Ze.-Bu., Sakh., Uss.; Centr. Asia: Ar.-Casp., Balkh., Dzu.-Tarb. **Gen. distr.:** Scand., Atl. and Centr. Eur., Med., Bal.-As. Min., Mong., Jap.-Ch., N. Am. Described from Europe. Type in London.

Economic importance. Poisonous to cattle and pigs, while reports concerning horses are conflicting. The plant contains the toxic alkaloid equisetin which acts upon the nervous system. The plant is dangerous if present in quantity in the hay. A noxious weed.

6. *E. heleocharis* Ehrh. Beitr. L. Naturgesch. 11, 159 und Hannov. Mag. (1783) 286; Kryl., Fl. Zap. Sib. 1, 55.— *E. limosum* L. Sp. pl. (1753) 1062; Ldb. Fl. Ross. IV, 489.— *E. fluviatile* L. Fl. Lapp. (1737) 310.— Ic.: Fl. Dan. XX; tab. 2925.— Exs.: Hayek Fl. Stir. exs., No. 706, 707.

Perennial; rhizome dark brown, 2–5 mm thick; stems 20–150 cm long, rather stout, with smooth ridges and a single large central cavity, simple (f. *limosum* Asch. u. Gr.) or branched (f. *fluviatile* Asch. u. Gr.); branches with minutely tuberculate ridges; teeth of ramal sheaths somewhat pointed, those of primary sheaths lance-subulate, brown, tightly appressed to stem; cone blunt. June, July.

Lake shores, thickets, marshes, canals, etc., often forming thick stands in water.— Arctic: Arc. Eur.; European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., V.-Kama, U. and M. Dnp., V.-Don, Transv., Bl., L. Don; Caucasus: Cisc., W., E. and S. Transc.; W. Siberia: Ob, U. Tob., 109 Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Ze.-Bu., Uss., Uda, Sakh., Kamch.; Centr. Asia: Ar.-Casp., Balkh. **Gen. distr.:** Scand., Centr. Eur., Atl. Eur., Med., Bal.-As. Min., Mong., Jap.-Ch., N. Am. Described from Europe. Type in London.

Economic importance. Readily eaten by cattle, without producing any disease symptoms; the branched form preferable, as it provides a more tender feed.

7. *E. litorale* Kühlew. in Rupr. Fl. Petrop. diatr. (1845) 91.— *E. inundatum* Lasch. in Rabenh. Bot. Centralbl. 2 (1846) 25.—

E. arvense inundatum Rabenh. Crypt. Fl. v. Deutschl. II (1848) 333.— Ic.: Journ. of Botany XXV (1887), tab. 273.— Exs.: Meinsh. Fl. Ingrica, No. 816.

Perennial; stems 15–75 cm long, with 15 or 16 ridges, the rather large central cavity narrower than in *E. limosum* and broader than in *E. arvense*; branches numerous, verticillate (the upper part of the stem often unbranched), mostly with or rarely without central cavity, simple; teeth of primary sheaths lanceolate or lance-subulate, mostly blackish-brown, those of ramal sheaths oblong-triangular and often long-tapering; cone blunt. June, July. (Plate V, Figure 3).

Shoals.— Arctic: Arc. Sib.; European part: Kar.-Lap., Lad.-Ilm.; E. Siberia: Yen., Lena-Kol. **Gen. distr.:** Scand., Centr. Eur., Atl. Eur., N. Am. Described from Europe (Oranienbaum [Lomosonov], near Leningrad). Type in Leningrad.

Note. Generally considered a hybrid between *E. arvense* and *E. limosum*, but this view is disputed by American authors (Schaffner). Usually growing in large groups, but distribution not adequately ascertained. More closely resembling in appearance *E. palustre*.

Section 2. **HIPPOCHAETE** Milde; *Equiseta cryptopora* Milde (characters in the key).

8. ***E. ramosissimum*** Desf. Fl. Atl. II (1800) 398; Kryl., Fl. Zap. Sib. 156.— *E. ramosum* DC Syn. pl. Fl. Gall. (1806) 118; Ldb., Fl. Ross. IV, 489.— *E. elongatum* Willd. Sp. pl. V (1810) 8.— *E. multicaule* Ldb. l. c. (1853) 490.— Ic.: Milde Monogr. Equis. tab. 24.— Exs.: Schultz Fl. gall. et germ. exs., No. 96.

Perennial; stems 30–100 cm long, rather rigid, cinerous, verticillately branched in lower part, with few (2–5) branches in a whorl, rarely the stem simple or with solitary branches (var. *simplex* Milde); ridges distinctly brownish; stomata in 1–4 linear rows; branches with a narrow centrum and small vallecular cavities; teeth of sheaths short, triangular, mostly with a dark spot, gradually tapering to a scarious lance-subulate caducous tip; cone pointed. May–July. (Plate V, Figure 7 a–c).

Sands, chalk, outcrops, bluffs, and pebble beds of the steppe and semidesert regions.— European part: V.-Kama, V.-Don, Bl., Transv., 110 L. V., L. Don, Crim.; Caucasus: Cisc., Dag., W. and E. Transc., S. Transc., Tal.; W. Siberia: U. Tob., Irt. (Omsk), Alt.; Centr. Asia: Ar.-Casp., Balkh., Dzu.-Tarb., Kara K., Syr D., Pam.-Al., T. Sh. **Gen. distr.:** S. part of Centr. Eur., Med., Bal.-As. Min., Arm.-Kurd., Iran., N. Ind.-Him., Dzu.-Kash., Mong., Tib., Jap.-Ch., Am., Afr. Described from N. Africa. Type in Florence.

9. ***E. hiemale*** L. Sp. pl. (1753) 1062; Ldb. Fl. Ross. IV, 490; Kryl., Fl. Zap. Sib. 1, 57.— Ic.: Lindmann Bild. ur Nord. Fl. II (1905), tab. 513.— Exs.: Fl. exs. Bohemi-Sloven, No. 9.

Perennial; stems 50–125 cm long, perennial, firm, rigid, mostly simple, very rarely short-branched (var. *ramigerum* A. Br.); ridges 10–30, each bearing a double row of tubercles; centrum large; teeth of sheaths tightly appressed to stem, mostly black at base, apparently truncate, the linear-subulate tips early caducous, persistent only in the uppermost whorl and on young stems; cone pointed. June–August. (Plate V, Figure 8 a–b).

Pine woods, sunny slopes of river terraces, woody gullies, banks of mountain streams, etc., mostly forming dense stands.— European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., V.-Kama, U. Dnp., M. Dnp., V.-Don, Transv., Bes., L. Don; Caucasus: Cisc., W. and E. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Ze.-Bu., Uda, Uss.; Centr. Asia: Ar.-Casp., Balkh., Dzu.-Tarb., Pam.-Al., T. Sh. **Gen. distr.:** Scand., Atl. and Centr. Eur., N. Med., Bal.-As. Min., Jap.-Ch. Described from Europe. Type in London.

Economic importance. Used instead of emery paper to clean metallic parts in tinplating and soldering, for furniture polishing, and for paper cleaning. For this purpose, it is first bleached by repeated wetting and drying. An infusion of the plant is used in popular medicine for treatment of arthritic rheumatism and as diuretic; in China it is applied against eye inflammations. In some places in Siberia the plant serves as forage for horses.

10. **E. Komarovi** Iljin sp. nova.— E. affine Rydberg (non Engelman) Fl. of the Rocky Mount. (1922) 1052.

Perennial; stems 40–100 cm long, simple, blackish-green, rigid, somewhat constricted above and below the nodes, with large centrum and numerous vallecular cavities; nodal sheaths on old stems appressed, on young ones campanulate, with a blackish-brown crossband at base; teeth 15–30, their teeth linear-lanceolate, flexuous, scarious, occasionally caducous; cone pointed. June–September. (Plate V, Figure 9).

111 Massive growth in woods, along rivers and streams, rarely in birch woods on mountain slopes. Far East: Kamch., Okh., Sakh. **Gen. distr.:** W. part of N. Am. Described from Kamchatka. Type in Leningrad.

Economic importance. Of considerable importance in Kamchatka as feed for horses; otherwise, like the preceding species.

11. **E. trachyodon** A. Br. in Flora XXII (1839) 305; Fom. in Fl. cauc. crit. 1 (1912) 210.— Ic.: Hook Brit. Ferns tab. 65.— Exs.: Schultz Fl. gall. et germ. exs., No. 1578.

Perennial; stems 20–60 cm long, perennial, rather rigid, simple or rarely with solitary branches; ridges 7–14, with a double row of distinct tubercles and a groove between them; centrum surrounded by smaller vallecular cavities; cone pointed. June–August. (Plate V, Figure 10a–b).

Clearings in coniferous woods.— Caucasus: Cisc. **Gen. distr.:** Atl. Eur. Described from Germany (Rhineland). Type in Leipzig.

12. **E. variegatum** Schleich. Cat. pl. helvet. (180) 27 nom. nud. Weber und Mohr Bot. Tasch. (1807) 60 et 447; Kryl., Fl. Zap. Sib. I, 58; Fom. in Fl. cauc. crit. 1 (1912) 211.— E. reptans β variegatum Wahl. Fl. Lapp. (1812) 398.— E. hiemale variegatum Newm in The Phytol. (1842) 337.— Ic.: Svensk. Bot. X, tab. 702.— Exs.: Pl. Finnl. exs., No. 415; HFR, No. 799.

Perennial; stems 6–30 cm long, perennial, slender, mostly numerous; rhizome branched, brownish-black, often producing tufts; stems simple, with a rather small centrum and smaller vallecular cavities; ridges 4–12, with two rows of tubercles and a groove between them; teeth of nodal sheaths oblong-ovate, almost black in lower part, with a brown median line and a broad white margin above, terminating in a slender blackish-brown

subulate often caducous tip. Cone pointed. April-August. (Plate V, Figure 11, a—b).

Peat bogs, tundras, mossy coniferous woods, and terraces of river valleys. Arctic: Arc. Eur., Nov. Z., Arc. Sib.; European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., V.-Kama, U. Dnp.; Caucasus: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Kamch., Okh., Ze.-Bu., Uss. **Gen. distr.:** Arctic, Scand., Centr. Eur., Atl. Eur., Mong. (Tannu-Ola), Ber., N. Am. Described from Switzerland. Type in Lausanne.

13. **E. scirpoides** Michx. Fl. bor. amer. II (1803) 281.— *E. hiemale tenellum* Liljebl. Utk. t. en Svensk. fl. (1798) 384.— *E. lapponicum* Fisch. in herb. hort. bot. Petrop. sec. Milde.— *E. tenellum* Ldb. in hort. bot. Petrop. sec. Milde.— Ic.: Milde Monogr. Equis. t. 35.— Exs.: Pl. Finl. exs., No. 416.

112 Perennial; stems 6—25 cm long, numerous, very slender, bent, often decumbent, simple or only at base branched, without centrum and but 3 vallecular cavities; teeth of nodal sheaths 3, ovate, white-margined, gradually attenuate to a long tip; cone pointed, concealed to the middle or higher up within the terminal whorl. May-July. (Plate V, Figure 12 a—b).

Mossy coniferous woods and tundras.— Arctic: Arc. Eur., Nov. Z., Arc. Sib. (?); European part: Dv.-Pech., Lad.-Ilm., V.-Kama; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Kamch., Okh., Ze.-Bu., Uda, Uss. **Gen. distr.:** Arctic, Scand., Ber., Arc. Am. Described from Canada.

Class III. LYCOPODIALES

Roots and stems forking; leaves small, rarely whorled, commonly covering the stem in a dense spiral; sporangia solitary at the base of leaves or in the leaf axil, unilocular; sporophylls scattered among sterile leaves or gathered in terminal cones [strobiles]; spermatozoids biciliate.

Series 1. **Eligulatae**

Leaves without ligule; spores all of one kind; prothallia large, often cormlike, containing the spores (see page 140, Series 2).

Family VIII. **LYCOPODIACEAE** L. C. RICH

L. C. Rich, apud Fb. Boc-amen, II (1803) 281.

Arranged by M. M. Il'in

Prothallia fully or partly buried, cormlike and turning green or in the form of strands destitute of chlorophyll and living saprophytically under flakes of peeling bark (*L. phlegmaria*), often cormlike and saprophytic

without chlorophyll; sporophyte with monopodially branching stem containing a single closed vascular bundle; leaves narrow and pointed or scalelike; sporangia 2-valved. Two genera.

Genus 34. **LYCOPodium** * L.

L. Sp. pl. (1753) 1100.

Evergreen plants with procumbent or erect stems, often with a branched underground rhizome; leaves numerous, small, entire, spirally arranged, in dorsiventral forms apparently decussate; sporangia solitary, in the axils of ordinary leaves or in distinct strobiles.

Fossil finds very rare; known only from the middle Pliocene of V. -Don (Voronezh).

1. Sporangia in the axils of ordinary leaves; strobiles none 2.
- + Sporophylls in strobiles at the ends of branches or of the main stem 5.
2. Leaves narrowed at base, distinctly serrate 1. **L. serratum** Thunb.
- + Leaves slightly enlarged toward base, entire or sparingly and obscurely toothed 3.
3. Leaves thin, linear-subulate, mostly ca. 0.5 mm (rarely up to 7.5 mm) broad, several times as long as broad 4. **L. chinense** Christ.
- + Leaves rather rigid, linear-lanceolate, 0.75—1.5 mm broad 4.
4. Stems together with the covering leaves 6—8 mm thick; leaves spreading or erect, not tightly appressed to stem 2. **L. selago** L.
- + Stems together with covering leaves to 4 mm thick; leaves always tightly appressed to stem; plants yellowish 3. **L. appressum** (Desv.) V. Petr.
5. Sporophylls scarcely differing from vegetative leaves and thus strobile not strongly differentiated from the stem 5. **L. inundatum** L.
- + Sporophylls markedly different from leaves; strobile strongly differentiated from the stem and from its peduncle. 6.
6. Strobiles sessile 7.
- + Strobiles more or less distinctly pedunculate 12.
7. Stems erect (not counting the rhizome), branching treelike; branches crowded or fanlike or compactly tufted 8.
- + Stems creeping, the branches ascending or erect 9.
8. Branches dorsiventral, flat in cross section, the lateral leaves arranged in the same plane as the branch 6. **L. obscurum** L.
- + Branches round in cross section; all leaves arranged in planes perpendicular to branches 7. **L. juniperoideum** Sw.
9. Leaves of fertile stems spirally arranged, those of vegetative branches opposite, flat and spirally recurved through half a turn toward the paler ventral side of the branch 13. **L. alpinum** L.
- + Leaves all alike, arranged spirally on all stems 10.
- 114 10. Leaves rather thick, gibbously convex beneath, acute or mucronate (Kamchatka) 14. **L. sitchense** Rupr.
- + Leaves flat on both faces, with merely the midrib sometimes protruding, gradually acuminate 11.
11. Plants mostly green, 15—25 cm long; stem creeping, densely leafy; branches not in dense groups, without constrictions; leaves

* From Greek lycos, a wolf, and podion, foot, paw, i.e., wolf's paw.

- horizontal, pubescent toward base, very rarely ascending; strobiles 25—40 mm long; plants of the forest region. 8. *L. annotinum* L.
- + Plants mostly yellowish, 3—12 cm long; stem creeping, with sparser and smaller leaves; branches in compact groups, with constrictions; leaves mostly erect and appressed to the stem, entire; strobile 9—13 cm long; plants growing chiefly in the tundra, in forest-tundra, and in the alpine zone 9. *L. pungens* La Pylae.
12. Leaves ordinary, linear, prolonged into a long white bristle, all spirally arranged; branches terete, alike on all sides 10. *L. clavatum* L.
- + Leaves on vegetative branches scalelike, opposite, never bristle-tipped; branches flat, dorsiventral 13.
13. Branches narrowly linear, 1.5—1.8 mm broad, very numerous, in compact clusters; ventral and dorsal leaves subequal; glaucescent plants. 12. *L. tristachyum* Pursh.
- + Branches 2—4 mm broad, in a looser fanlike arrangement; dorsal leaves 2—3 times as long as the ventral; green plants 11. *L. anceps* Wallr.

Section 1. **SELAGO** (Dillen.) Pritz. in Engl. u. Prantl Pflanzf. I, IV (1902) 592. Sporangia in the axils of ordinary leaves; distinct strobiles none.

1. *L. serratum* Thunb. Fl. Japon. (1784) 341.—Kom. Fl. Mansch. 1, 158.—Ic.: 1. c., tab. 38.—Exs.: Fl. of temper. Japon. distr. by Tanaka, No. 20872.

Perennial, dark green, simple or dichotomously branched plants, 10—25 cm tall; leaves narrowly lanceolate, narrowed toward base, acuminate, distinctly and irregularly serrate, 1-nerved, spreading or reclinate, sporangia in the axils of all but the lowest common leaves; spores smooth, weakly trilobate. June–September. (Plate VI, Figure 3 a–b).

Mossy coniferous woods.—Far East: Uss., Sakh. **Gen. distr.:** Ind.-Him., tropical Asia, Jap.-Ch. Described from Japan. Type (probably) in Sweden (Uppsala University).

2. *L. selago* L. sp. pl. (1753) 1102; Ldb. Fl. ross. IV, 496; Fom. in Fl. cauc. crit. 1, 215; Kryl., Fl. Zap. Sib. 1, 60; Turcz. Fl. baic.-dah. II, 115 fac. 2, 358.—*L. recurvum* Kit. in Willd. Sp. pl. V (1810) 50.—Ic.: Lindman. Bild. ur Nord. Fl. II (1905), t. 516.—Exs.: Fl. Hung. exs. No. 433; Sredinsky Herb. crypt. ross. No. 24.

Perennial; stems 5—25 cm long, erect or somewhat ascending at base, dichotomously branched; leaves linear-lanceolate, spreading or ascending, stiffish, acute, entire or sparingly and weakly crenulate; sporangia in the axils of ordinary, mostly the middle, leaves; spores almost smooth. July–October. (Plate VI, Figure 1 a–b).

Mossy woods and alpine meadows.—European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., V.-Kama, U. Dnp., V.-Don, Transv., L. Don, L. V.; Caucasus: Cisc., W. Transc., E. Transc.; W. Siberia: Ob, Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Day.; Far East:

Kamch., Ze.-Bu., Uss., Sakh.; Centr. Asia: Dzu.-Tarb. **Gen. distr. :** nearly cosmopolitan. Described from N. Europe. Type in London.

Economic importance. A popular source of yellow wool dye. An infusion of the plant is used in popular medicine.

3. **L. appressum** (Desv.) Petr. Fl. Jakut. 1 (1930) 37.— L. Selago f. *appressum* Desv. Ann. Soc. Linn. Paris VI (1827) 180.— Ic. : Petrov, Fl. Yakutii 1 (1930), Figure 21.

Perennial, yellowish-green plants; stems 2–10 cm long, erect or at base ascending, forking; leaves short-tapering from ovate base, entire, subulate-tipped, compactly imbricated and tightly appressed to the stem; sporangia in the axils of ordinary leaves and reproducing by readily deciduous axillary buds. (Plate VI, Figure 2 a–b).

Tundras of arctic and alpine regions.— Arctic: Arc. Eur., Arc. Sib., Chuk., An. **Gen. distr. :** Arctic, N. Scand., Arc. Am., Ber. Described as a form, from Europe.

Note. This species, raised by V. A. Petrov from a form to the status of a species, represents as yet a very young race, connected with the type by numerous transitions, and we grant it the standing of species for reasons of expediency.

4. **L. chinense** H. Christ in Baroni et Christ, Filic. in Schensi septentr. etc. IV (1897) 101.— Ic. : I. c.

Perennial, bright green, dichotomously branched plants, 10–25 cm long; stems ascending at base; leaves narrow, linear, gradually acuminate, entire, spreading, pubescent beneath, the upper ones erect; offsets in the axils of upper leaves often exceeding the leaves; spores smooth, slightly 3-lobed. July–August. (Plate VI, Figure 4 a–b).

116 Mossy woods.— Far East: Uss., Sakh. **Gen. distr. :** Jap.-Ch. Described from Shensi Province in China.

Section 2. **INUNDATA** (Baker p. p.) Pritz. in Engl. u. Prantl. Nat. Pflanzenfam. 1, IV (1902) 601.— Strobile not contrasted strongly with the rest of the stem; sporophylls [bracts] somewhat resembling the foliage-leaves, strongly divergent.

5. **L. inundatum** L. Sp. pl. (1753) 1102.— Ic. : Svensk. Bot. IX (1823–25), t. 612, f. 1.— Exs. : Hayek. Fl. Stir. exs. No. 1104; Fl. Hung. exs. No. 534.

Perennial; stems creeping, densely leafy; leaves linear-subulate, entire, subfalcately recurved from base, all turned toward one side, tapering to a slightly rounded tip; fruiting stems 2–10 cm long, loosely covered with strongly divergent leaves, gradually passing into a cylindric strobile; bracts divergent, with a broad sparingly toothed base, prolonged into a long tip. July–October. (Plate VI, Figure 5 a–b).

Mossy coniferous woods, boggy meadows, and swamps. European part: Lad.-Ilm., U. V., V.-Kama, U. Dnp., V.-Don, Bl.; Caucasus: W. Transc. **Gen. distr. :** Scand., Atl. Eur., Centr. Eur., N. Am. Described from Europe. Type in London.

Section 3. **CERNUA** (Baker p.p.) Pritz. in Engl. u. Prantl Nat. Pflanzfam. 1, IV (1902) 602.— Plants with erect bushy-forking stem; subterranean creeping rhizome almost leafless; strobile sharply contrasted with the remaining part of the stem.

6. **L. obscurum** L. Sp. pl. (1753) 1102.— **L. dendroideum** Michx. Fl. Bor. Am. II (1803) 282.— **L. japonicum** Thunb. Fl. Japon. (1784) 341.— Ic.: Britt. and Brown. Ill. Fl. North. U.S., I. (1896) 41, Figure 92.

Perennial; stems from creeping rhizome, erect, 10–25 cm high, chiefly in upper part fanlike bush-branched; leaves on main stem more scattered, spreading, with tip somewhat projected forward; leaves on branches approximate, linear-lanceolate, entire, short-acuminate, subfalcately upcurved, the lateral leaves in one plane with the branch, the ventral side centrally appressed, the branches thus apparently bilateral; strobiles cylindric; bracts rounded-ovate, abruptly pointed, the wavy membranous margin crenate. July–September. (Plate VI, Figure 10 a–b).

Coniferous woods.— Far East: Uss. **Gen. distr.**: Jap.-Ch., N. Am. Described from Philadelphia in the U. S. A. Type in London.

7. **L. juniperoideum** Sw. Syn. fil. (1789) 178.— **L. dendroideum** Ldb. (non Michx s. str.) Fl. Ross. IV (1853) 498.— **L. dendroideum** f. *stricta* Milde Fil. Eur. et Atl. (1867) 254.— **L. obscurum** f. *juniperoideum* Takeda Lycop. Hokkaidos in Tok. Bot. Mag. (1909) 213.— **L. obscurum** proles *juniperoideum* Kom. Fl. Kamtsch. I (1927), 89.

117 Perennial, pale green plants, with creeping rhizome; stems 6–25 cm long, compactly and repeatedly bushy-branched from lower third; branches, as opposed to the preceding species, not bilateral, in cross section together with leaves round and not semiorbicular or flattened; leaves resembling those of the preceding species, but all arranged in planes perpendicular to the branch, subfalcately upcurved and subappressed; strobiles sessile, the bracts resembling those of the preceding species. July–September. (Plate VI, Figure 9 a–b).

Mossy coniferous woods.— E. Siberia: Dau., Lena-Kol.; Far East: Kamch., Okh., Ze.-Bu., Sakh., Uss. (only at the boundary with Uda). **Gen. distr.**: mountains of Jap.-Ch., N. Am.

Section 4. **CLAVATA** (Baker p.p.) Pritz. in Engl. u. Prantl Pflanzenfam. 1, IV (1902), 603. Rhizomes leafy; stems creeping; strobiles strongly contrasted with the rest of the stem.

8. **L. annotinum** L. Sp. pl. (1753) 1103; Ldb. Fl. Ross. IV, 497; Fom. in Fl. cauc. crit. I, 218; Kryl., Fl. Zap. Sib. 1, 61; Turcz. Fl. baic.-dah. II, 358; Shmal'g. II, 677.— Ic.: Svensk. Bot. VIII (1819), t. 570.— Exs.: HFR, No. 749; Fl. Hung. exs. No. 434.

Perennial; stems long, creeping, 10–30 cm long, with dichotomously forking branches; leaves linear-lanceolate, acuminate, stiffish, spreading, the margin thinly serrulate; strobiles solitary, sessile; bracts rounded-ovate, pointed. July–September. (Plate VI, Figure 7 a–b).

Coniferous woods.— European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., U. Dnp., V.-Don, V.-Kama; Caucasus: Cisc., W. Transc.;

W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Kamch., Okh., Ze.-Bu., Uda, Uss., Sakh. **Gen. distr.**: Scand., Centr. Eur., Atl. Eur., N. part of Med. (N. Apennines), N. part of Bal. As. Min. Described from Europe. Type in London.

9. **L. pungens** La Pyl. in Desv. Mem. Soc. Linn. Paris VI (1827) 182.— *L. annotinum* var. *pungens* Desv., l.c.— *L. reclinatum* Michx. in Spring. Monogr. (1842–1845), 78.— Ic.: Fl. danica, t. 2984.

Perennial, yellowish-green plants 3–10 cm long; stems creeping; branches numerous, subapproximate, erect, with distinct constrictions due to annual accretions; leaves upright, appressed to stem, with recurved tips, very stiff, entire; strobiles oblong-ovate. August. (Plate VI, Figure 8 a–d).

Arctic and alpine tundras; forest tundra.— Arctic: Arc. Eur., Arc. Sib., Chuk., An.; European part: N. part of Kar.-Lap., Dv.-Pech.; W. Siberia: N. Ob; E. Siberia: N. Yen., Lena-Kol, Ang.-Say. (Baikal), Dau. (Baikal); Far East: Kamch., Okh., Sakh. **Gen. distr.**: Arctic, N. Scand., Ber., Arc. Am. Described from Newfoundland.

118 10. **L. clavatum** L. Sp. pl. (1753) 1101; Ldb. Fl. Ross. IV, 499; Turcz. Fl. baic.-dah. II, 359; Kryl., Fl. Zap. Sib. 1, 62; Fom. in Fl. cauc. crit. II, 219.— *L. aristatum* Bong. Veget. ins. Sitcha (1887) 175.— Ic.: Lindman. Bild. ur. Nord. Fl. II (1905), t. 517, A. Exs.: HFR No. 149; Fl. Hung. exs. No. 435.

Perennial; stems long, creeping; branches ascending, branched, densely leafy; leaves linear to linear-lanceolate, entire, upcurved, prolonged into a long white bristle; strobiles mostly in pairs, rarely in 3's or 4's or solitary, linear-cylindric, borne on long peduncles, with distant crenulate point-tipped leaves; bracts broadly ovate, crenate. July–August. (Plate VI, Figure 6 a–b).

Coniferous woods.— Arctic: Arc. Eur., Arc. Sib., Chuk.; European part: Kar.-Lap., Lad.-Ilm., V.-Kama, U. Dnp., V.-Don, Transv.; Caucasus: W. Transc.; W. Siberia: Ob, Irt., Alt.; E. Siberia: Yen, Lena-Kol., Ang.-Say., Dau.; Far East: Kamch., Okh., Ze.-Bu., Uda, Uss., Sakh. **Gen. distr.**: Arctic, Scand., Centr. Eur., Atl. Eur., N. Bal.-As. Min., Mong., Jap.-Ch., N. Am.; other races undoubtedly occur in Africa, Australia, tropical Asia and America. Described from Europe. Type in London.

Economic importance. The spores are used as baby powder and as binding material for pills; they are also employed in the manufacture of fireworks. They contain about 47.5% of nondrying fatty oils (glycerides, and oleic, palmitic, stearic, and myristic acids, etc.), as well as

121 phytostearin, proteins, sugar, minerals, etc. They were used in large amounts in cast-iron foundries for dressing molds, and therefore it used to be an export article of great importance. In Sweden the plant is used for mat weaving.

11. **L. anceps** Wallr. in Linnaea XIV (1840) 676.— *L. complanatum* L. Sp. pl. (1753) 1104 (p.p.); Ldb. Fl. Ross. IV, 499; Turcz. Fl. baic.-dah. II, 359; Kryl., Fl. Zap. Sib. 1, 64; Fom. Fl. cauc. crit. I, 220.— *L. complanatum* var. *flabellatum* Doll. Fl. v. Baden I (1855) 79.— *L. complanatum* var. *anceps* Aschers Fl. v. Brand. I (1864) 894.—

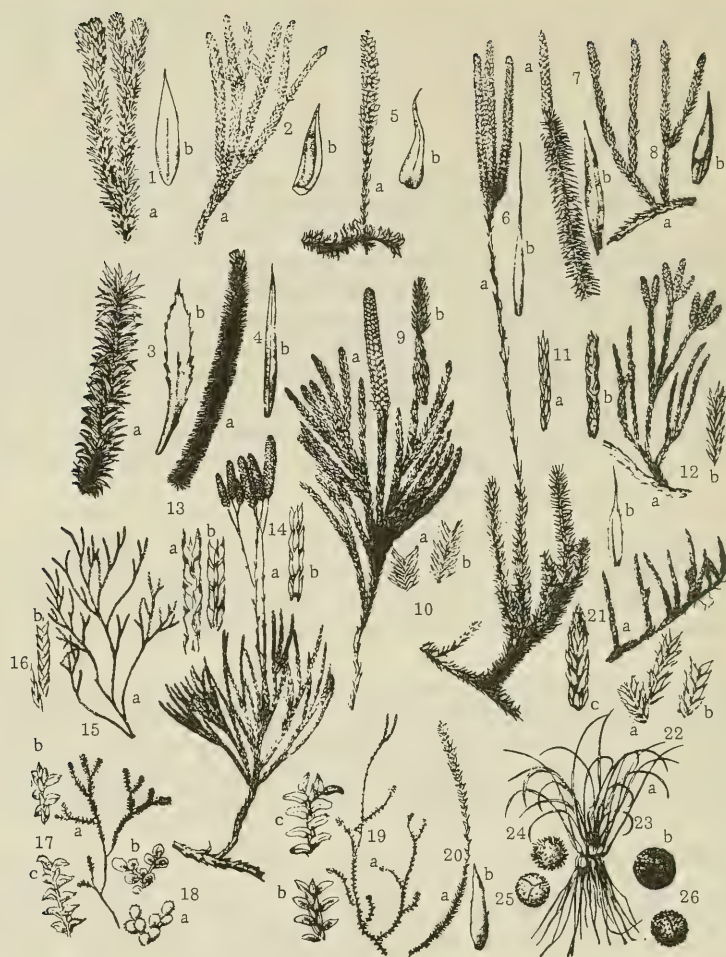


Plate VI

1. *Lycopodium selago* L.: a) general aspect; b) leaf.—2. *L. appressum* Petr.: a) general aspect; b) leaf.—3. *L. serratum* Thunb.: a) general aspect; b) leaf.—4. *L. chinense* H.Christ.: a) general aspect; b) leaf.—5. *L. inundatum* L.: a) general aspect; b) leaf.—6. *L. clavatum* L.: a) general aspect; b) leaf.—7. *L. annotinum* L.: a) general aspect; b) leaf.—8. *L. pungens* Pyl.: a) general aspect; b) leaf.—9. *L. juniperoideum* Sw.: a) general aspect; b) fragment of a branch.—10. *L. obscurum* L.: a) ventral view of a branch fragment; b) dorsal view of same.—11. *L. alpinum* L.: a) dorsal view of a branch fragment; b) ventral view of same.—12. *L. sitchense* Rupr.: a) general aspect; b) branch.—13. *L. anceps* Wallr.: a) ventral view of a branch; b) dorsal view of same.—14. *L. tristachyum* Pursh.: a) general aspect; b) branch.—15. *Selaginella Aitchisonii* Hieron.: a) general aspect; b) branch.—16. *S. sanguinolenta* Spring.: branch.—17. *S. Rossii* Warbr.: a) general aspect; b) dorsal view of a branch fragment; c) ventral view of a branch fragment.—18. *S. borealis* Rupr.: a) dorsal view of a branch fragment; b) ventral view of a branch fragment.—19. *S. helvetica* Link.: a) general aspect; b) dorsal view of a branch fragment; c) ventral view of same.—20. *S. selaginoides* Link.: a) fruiting stem; b) leaf.—21. *S. sibirica* Hieron.: a) general aspect; b) leaf; c) branch.—22. *S. involvens* Spring.: a) dorsal view of a branch fragment; b) ventral view of same.—23. *Isoetes lacustris* L.: a) general view; b) macrospore.—24. *I. echinospora* Dur.: macrospore.—25. *I. berlingensis* Kom.: same.—26. *I. asiatica* Makino: same.

Ic.: Hegi. Ill. fl. Mittel. Europ. I, t. 11, fig. 5; Syreishch., Ill. Fl. Mosk. gub. I (1906) 56.— Exs.: HFR No. 200; Fl. Stir. exs. No. 80.

Perennial; stem creeping; branches bilateral, ascending or erect, strongly flattened, in fanlike arrangement, forking; leaves tightly appressed to branches, the lateral scalelike, opposite and decurrent, those on the flat sides lance-subulate, the dorsal 2—3 times as long as the ventral; strobiles in 2's to 6's, on long slender peduncles, these bearing distant subulate-lanceolate leaves; sporophylls rounded-ovate, attenuate at apex. July-August. (Plate VI, Figure 13 a—b).

Pine and mixed pine and broad-leaved woods, rarely spruce-and-fir woods.— Arctic: Arc. Eur. (?); European part: Kar.-Lap., Dv.-Pech., Lad.-Ilm., V.-Kama, U. Dnp., V.-Don, Transv.; W. Siberia: Ob, Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Kamch., Okh., Ze.-Bu., Uda, Uss., Sakh. **Gen. distr.**: Scand., Centr. Eur., partly Atl. Eur., N. Med. (N. Apennines), N. Bal.-As. Min. (Rumania), Mong., Jap.-Ch., W. part of N. Am. Described from Germany (Harz). Type in Leipzig (University).

Economic importance. A popular source of a green wool dye.

12. *L. tristachyum* Pursh Fl. Amer. sept. (1814) 653.—

L. Chamaecyparissus A. Br. in Mutel, Fl. franc. IV (1837) 192.— *L. complanatum* var. *Chamaecyparissus* Döll. Fl. Bad. I (1855) 80.— *L. complanatum* var. β *sabinaefolium* Rupr. (non Willd.) in Beitr. z. Pflanzenk. d. Russ. R. III (1845). 30.— Ic.: Hegi Illustr. Fl. Mittel-Europ. I, fig. 28 and 29.— Exs.: Fl. exs. austro-hung. No. 701.

Perennial; stems creeping; branches glaucescent, erect, clustered but not fanlike as in the preceding species, narrower and less flattened; leaves resembling those of the preceding species but the dorsal and ventral subequal, and thus branches but faintly dorsiventral; strobiles similar to those of the preceding species. July-September. (Plate VI, Figure 14 a—b).

Sandy woods.— European part: Kar.-Lap., Lad.-Ilm., U. Dnp., V.-Don 122 (Orel). **Gen. distr.**: Scand., Centr. Eur., Atl. Eur., Med. (Apennines), Bal.-As. Min., E. part of N. Am. Described from the U. S. A. (Sweetsprings, Virginia).

13. *L. alpinum* L. Sp. pl. (1753) 1104; Ldb. Fl. Ross. IV, 498; Turcz. Fl. baic.-dah. II, 359; Kryl., Fl. Zap. Sib. 1, 65; Fom. in Fl. cauc. crit., 221.— *L. chamarense* Turcz. in Ldb. Fl. Ross. IV (1853) 498; Spring in Flora I (1838) 180.— *L. complanatum* var. γ *alpinum* Spring, l. c.— Ic.: Hook. Brit. Ferns, t. 53.— Exs.: Fl. Hung. exs. No. 535.

Perennial; stems creeping; branches erect, repeatedly forking, clustered, scarcely or very slightly flattened; leaves lateral, ovate-lanceolate, connate and adnate to the branch up to the middle, the dorsal and ventral oblong, all rather thick and pointed, appressed to branches; strobiles sessile; bracts broadly ovate, tapering to a narrow tip, the margin incised. July-August. (Plate VI, Figure 11 a—b).

Tundras and the alpine mountain zone.— Arctic: Arc. Eur., Nov. Z., Arc. Sib.; European part: Dv.-Pech.; Caucasus: Gr. Cauc., W. Transc.; W. Siberia: Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Kamch., Okh., Uss. **Gen. distr.**: Arctic, alpine zone of W. Eur., Arm.-Kurd., Mong., Jap.-Ch., Ber., N. Am. Described from Scandinavia (Lapland). Type in London.

14. *L. sitchense* Rupr. Distr. crypt. vasc. (1845) 30.— *L. alpinum* var. *sitchense* Milde Fil. Eur. (1867) 258.—

Perennial; resembling the preceding species, from which it differs chiefly in its branches being more rounded and not at all dorsiventral; leaves narrower, lance-linear, acuminate or acute, alike on all sides, divergent, the tip curved toward the stem. August. (Plate VI, Figure 12 a—b).

Subalpine and alpine mountain zones.— Far East: only in Kamchatka. **Gen. distr.:** Ber. Described from Sitka Island in the U. S. A. Type in Leningrad.

Series 2. **Ligulatae**

Leaves ligulate; spores of two kinds: macrospores and microspores; prothallia but slightly exserted from spores; prothallia bearing antheridia greatly reduced; prothallia bearing archegonia formed by concurrent development of numerous cells; secondary thickening of stem not in evidence.

Family IX. **SELAGINELLACEAE** METTEN.

Arranged by M. M. Il'in

Microsporangia globose, ovoid or broadly reniform, with numerous globose-tetrahedral microspores; macrosporangia much larger, with but 4 macrospores.

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Genus 35. **SELAGINELLA** * SPRING.

Rather small mosslike plants, more or less compactly tufted, often with dorsiventral stems; leaves alternate or 4-ranked; sporangia in the axils of leaves in terminal spikes; macrosporangia in the lower, microsporangia in the upper part of the spike.

Known fossils from the upper Tertiary and Quaternary formations: *S. selaginoides* Lk. in the Riss-Würmian of L. V. (Chernyi Yar, Nikol'skoe, etc.) and in the Mindel-Rissian of U. V. (Moscow); *S. helvetica* L. in the Riss-Würmian of V. -Don (Podkletnoe).

1. Leaves decidedly spreading, mostly perpendicular to the branch axis; spikes often cylindric 2.
- + All leaves tightly appressed to the stem, imbricated; spikes always 4-angled 4.
2. Leaves spirally and regularly arranged on all sides of the branches, with 2—4 teeth on each side; branches not dorsiventral; spikes ovaloid-cylindric 1. *S. selaginoides* (L.) Link.
- + Branches decidedly dorsiventral; lateral leaves perpendicular to the branch, the smaller dorsal ones appressed and arranged in two ranks 3.

* Diminutive form of *Selago*, a species of *Lycopodium*.

3. Leaves very delicate, the lateral ones regularly and very faintly toothed on the margin; spikes very slender, cylindric 8. *S. helvetica* Link.
- + Leaves stronger; lateral leaves ciliate on the margin on the auricles and up to the middle, the other side of the leaf entire; spikes 4-angled 6. *S. Rossii* (Bak.) Warbr.
4. Leaves terminating in a rather long colorless seta, this most prominent at the ends of young branchlets 5.
- + Leaves lacking a terminal seta 6.
5. Leaves lance-linear, channeled beneath, often ciliate-serrulate, with a crenulate seta; stems and branches terete or rounded-tetragonal, uniformly colored on all sides 2. *S. sibirica* (Milde) Hieron.
- + Leaves oblong-ovate, subentire, not channeled beneath, with a smooth seta; stems and branches flattened, paler beneath, forming a dense rosette 7. *S. involvens* Spring.
6. Vegetative branches dorsiventral; leaves broadly ovate, subentire, keeled at the top; leaves on stems and fertile branches sharply keeled, regularly covering the stem on all sides 3. *S. borealis* (Kaulf) Rupr.
- + All dorsal leaves sharply keeled down to base, regularly arranged on all sides of stems and branches, these not dorsiventral 7.
7. Leaves, mainly on one side, denticulate and often ciliate-denticulate (E. Sib.) 4. *S. sanguinolenta* (L.) Spring.
- + Leaves subentire (Turkestan) 5. *S. Aitchinsonii* Hieron.

Subgenus 1. **HOMOEOPHYLLUM** (Spring) Hieron. in Engl. u. Prantl, 1, IV (1902), p. 669. — Leaves all alike, spirally arranged.

Section 1. **CYLINDROSTACHYAE** Hieron., l. c. — Sporophylls arranged spirally or in numerous whorls.

1. *S. selaginoides* (L.) Link Fil. Hort. Berol. (1841) 158; Fom. in Fl. cauc. crit. 36, 224; Kryl., Fl. Zap. Sib. 1, 67. — *S. spinosa* Prodr. Aetheog. (1805) 112 P. B. — *S. spinulosa* A. Br. in Döll Rhein. Fl. (1843) 38. — *Lycopodium selaginoides* L. Sp. pl. (1753) 1101. — Ic.: Hieron. in Engl. u. Prantl. Pflanzenfam. I, 4 (1902) 670, fig. 401; Fedch. and Fler., Ill. opr. rast. Sib. (1909), Plate 4, Figure 2. — Exs.: Fl. Hung. exs. cent. IV, No. 335; HFR, No. 1648.

Perennial, small, inconspicuous, mosslike, very loosely tufted plants; leaves rather loosely spirally arranged, oblong to oblong-ovate, acuminate or acute, spreading, the margin with several very remote awn-tipped teeth; spikes solitary, ovate-cylindric, pedunculate, the peduncle much longer than the spike. Plants resembling in aspect *Lycopodium inundatum*. July-August. (Plate VI, Figure 20 a-b).

Wet meadows, northern peat bogs, and mossy woods. — Arctic: Arc. Eur., Arc. Sib.; European part: Kar. -Lap., Dv. -Pech., V. -Kama (Urals); Caucasus: Gr. Cauc.; W. Siberia: Ob; E. Siberia: Yen. (Turukhansk), Lena-Kol. (Aldan), Ang. -Say.; Far East: Kamch. **Gen. distr.**: Arctic, Scand., Atl. Eur., Centr. Eur. (Alps, Jura, Carpathians, N. Apennines), N. Am. Described from N. Europe. Type in London.

Section 2. **TETRAGONOSTACHYAE** Hieron, l. c. — Sporophylls decussate.

2. **S. sibirica** (Milde) Hieron. in Hedw. XXXIX (1900) 290. — *S. rupestris* f. *sibirica* Milde Filic. Eur. et Atl. (1867) 262. — *S. rupestris* Ldb. Fl. Ross. IV (1853) 500; Turcz. Fl. baic. -dah. 2, 360; Kryl., Fl. Zap. Sib. 1, 67 et auct. plur. ross. — *S. Schmidtii* Hieron., l. c., p. 292 (verosimiliter). — Ic.: Fedch. and Fler., Ill. opr. rast. Sib. I (1909), Plate 5, Figure 2.

Perennial, rather compactly tufted; branches short, ascending, forking, densely leafy; leaves imbricated, oblong to oblong-lanceolate, rather thick, channeled beneath, closely ciliolate on the margin, terminating in an unbranched crenulate seta; spikes 4-angled, to 4 cm long and to 2 mm in diameter. June-September. (Plate VI, Figure 21 a-c).

125 Rocks and taluses on sunny slopes. — W. Siberia: Alt. (?); E. Siberia: Lena-Kol., Ang. -Say., Dau.; Far East: Kamch., Okh., Ze. -Bu., Uda, Uss., Sakh. **Gen. distr.**: N. part of Jap. -Ch. Described from E. Siberia (Ayan and Dauria).

Subgenus 2. **HETEROPHYLLUM** (Spring) Hieron. in Engl. u. Prantl. I, IV (1902) 673. — Leaves of different kinds, decussate.

3. **S. borealis** (Kaulf) Rupr. in Beitr. z. Pflzk. Russ. R. III (1845) 32; Turcz. Fl. baic. -dah. 2, 361; Ldb. Fl. Ross. IV, 501. — *Lycopodium boreale* Kaulf. Enum. filic. (1824) 17. — Ic.: Fedch. and Fler., Ill. opr. rast. Sib. I (1909), Plate 5, Figure 3.

Perennial, loosely tufted, strongly branched plants; vegetative branches decidedly dorsiventral; leaves imbricated, tightly appressed to the stem; leaves on vegetative branches ovate, rather thick, obtuse or scarcely acute, subentire, arched and faintly obtuse-keeled on the back; stem leaves sharp-keeled, regularly arranged on all sides; spikes 4-angled, twice as thick as the peduncles. June-September. (Plate VI, Figure 18 a-b).

Rocks. — E. Siberia: Ang. -Say., Dau.; Far East: Kamch., Okh., Ze. -Bu., Uda, Uss. **Gen. distr.**: N. part of Jap. -Ch. Described from Kamchatka. Type in Leningrad.

4. **S. sanguinolenta** (L.) Spring Monogr. Lycop. in Mem. Akad. Roy. Sc. Belg. XXIV (1850) 57; Ldb. Fl. Ross. IV, 501; Turcz. Fl. Baic. -dah. 2, 360; Kryl., Fl. Zap. Sib. 1, 68. — *Lycopodium sanguinolentum* L. Sp. pl. (1753) 1101. — Ic.: Fedch. and Fler., Ill. opr. rast. Sib. I (1909), Plate 4, Figure 1.

Perennial, loosely tufted plants, resembling the preceding species. Distinguishing characters: branches not dorsiventral; leaves all ovate, sharp-keeled, shortly subulate-tipped, the margin mainly on one side closely ciliolate-denticulate; spikes 4-angled, scarcely thicker than the supporting branches. June-August. (Plate VI, Figure 16).

Rocks. — W. Siberia: Alt. (?); E. Siberia: Lena-Kol., Ang. -Say., Dau.; Far East: Okh., Ze. -Bu., Uda, Uss. **Gen. distr.**: N. Mong., Jap. -Ch. Described from E. Siberia (upper Yenisei according to Patrin's collections; this location appears first beside others). Type in Geneva.

5. *S. Aitchinsonii* Hieron. in Engl. u. Prantl Nat. Pflanzenfam. I, 4 (1902), 674.

Perennial, loosely tufted plants, resembling the preceding species; distinguishable by the leaves being even more sharply keeled, entire or rarely with few teeth barely discernible with the aid of a magnifying glass. (Plate VI, Figure 15 a—b).

Rocks.— Centr. Asia: T. Sh. **Gen. distr.** : Iran., Dzu.-Kash.— Described from two specimens from Afghanistan and Turkestan.

126 6. *S. Rossii* (Bak). Warburg Monsunia I (1900) 101.— *S. mongolica* var. *Rossii* Baker Handb. Fern-Allies (1887) 37.

Perennial, loosely tufted, strongly branched, the branches dorsiventral; leaves stiffish, ovate to oblong-ovate; lateral leaves perpendicular to the branch, spreading, with rather strongly revolute margins, auriculate; auricles and the convex upper margin of the leaf up to the middle sinuately dentate-ciliate; spikes 4-angled. (Plate VI, Figure 17 a—c).

Riverside rocks.— Far East: Uss. (Pos'et, Suifun). **Gen. distr.** : Jap.-Ch. (Manchuria).

7. *S. involvens* Spring Monogr. Lycop. in Mem. Acad. Roy. Sc. d. Belg. XXIV (1850), 63.— *S. pulvinatum* Hook. et Grev. Enum. fil., No. 98.— Ic. : Fedch. and Fler., Ill. opr. rast. Sib. I (1909), Plate 5, Figure 1:

Perennial, compactly tufted; stems branched, flattened, pale beneath, densely leafy, forming a dense rosette, rolling up in drought and spreading out in wet weather; leaves ovate to oblong-ovate, subentire, terminating in a colorless smooth seta; spikes 4-angled. July-October. (Plate VI, Figure 22 a—b).

Rocks.— Far East: Ze.-Bu., Uss. **Gen. distr.** : Jap.-Ch., tropical SE Asia. Described from numerous (6) locations, including nearly all E. and SE Asia, originally from Japan. Type in Liege (?).

8. *S. helvetica* (L.) Link Fil. Hort. Berol. (1841) 159.— *Lycopodium helveticum* L. Sp. pl. (1753) 1568.— Ic. Hieron. in Engl. u. Prantl Pflanzenfam. I, 4 (1902) 687, fig. 405; Fedch. and Fler., Ill. opr. rast. Sib. (1909), Plate 4, Figure 3.— Exs. : Sredinsky Herb. crypt. Rossic., No. 25; Fl. Hung. exsicc. No. 230.

Perennial, delicate plants, with creeping stem, the short dorsiventral branches rather sparingly leafy; leaves lateral, ovate-oblong, obtusish, the margin regularly and barely perceptibly toothed; central leaves smaller and narrower, appressed; spikes solitary or paired, linear-cylindric, with loose leaves, the rather long peduncles with spirally arranged sessile and very distant leaves. June-July. (Plate VI, Figure 19 a—c).

Damp mossy rocks and taluses.— Caucasus: Cisc., Dag., W. Transc., E. Transc.; E. Siberia: Dau. (Nerchinsk); Far East: Ze.-Bu., Uss. **Gen. distr.** : Centr. Eur. (Alps, Carpathians), Bal.-As. Min. (mountains of the Balkan Peninsula), Jap.-Ch. Described from Switzerland. Type in London.

Class IV. ISOETALES

Sporophyte with a short stem endowed with secondary growth in thickness and numerous long ligulate leaves; macro- and microspores in distinctive axils on the inner side of somewhat enlarged leaf bases; microspores producing minute 2-celled prothallia with an antheridium, this containing 4 multiciliate spermatozoids; macrospores developing small prothallia with 1 to several archegonia.

Family X. ISOETACEAE* BARTLING

Arranged by M.M. Il'in

Aquating or rooting in the mud; stem [corm] buried in the soil, producing numerous unbranched roots at base and a cluster of subulate erect or arched-recurved leaves at the top.

Genus 36. ISOETES L.

Stem 2- or 3-lobed, cormlike; leaves deciduous in fall; excavation containing macrosporangia divided into several chambers by thin strands of tissue; leaves bearing macrosporangia confined to the outermost part of the cluster, those bearing microsporangia behind them, and sterile leaves closest to the center of the leaf cluster; macrospores white.

1. Macrospores finely crested-rugose 1. *I. lacustris* L.
+ Macrospores densely covered with high warts or slender brittle spinules 2.
2. Leaves with stomata 4. *I. beringensis* Kom.
+ Leaves without stomata 3.
3. Velum narrow, covering less than one-third of the sporangium.
European part of USSR 2. *I. echinospora* Dur.
+ Velum broad, covering 2/3—3/4 of the sporangium. E. Asia 3. *I. asiatica* Makino.

Section 1. **CRISTATAE** Pfeifer Monogr. Isoet. in Ann. of the Miss. Bot. Gard IX (1922) 176.—Macrospores tuberculate, the tubercles sometimes extended into crests.

1. *I. lacustris* L. Sp. pl. (1753) 1100.—Ic. Svensk. Bot. IX (1823—1825) t. 600; Fedch. and Fler., Ill. opr. rast. Sib. (1909), Figure 71.—Exs.: Herb. Fl. Ingr. No. 822; Fl. exs. Rhenana No. 90.

Perennial, 5—20 cm high, the leaves arising in a cluster from a short cormlike rhizome; leaves erect, subulate, rather dark green, 1.5—2.5 mm long; macrospores prominently reticulate-crested. July–September. (Plate VI, Figure 23 a—b).

Lake bottoms.—Arctic: Arc. Eur.; European part: Kar. -Lap., 128 Lad. -Ilm., U. V., V. -Kama (?), U. Dnp.; W. Siberia: Ob (Iset. R. area).—**Gen. distr.**: Scand., Centr. Eur., Atl. Eur., N. Am. Described from N. Europe. Type in London.

* Derived from Greek *isos*, alike, and *etos*, year, referring to the evergreen habit of the plants. Name used by Pliny for a species of *Sedum*.

Section 2. **ECHINATAE** Pfeifer, l. c., p. 154. — Macrospores covered with sharp echinules.

2. **I. echinospora** Dur. in Bull. Soc. Bot. France VIII (1861) 164. — Ic. Lindman. Bilder ur. Nord. Fl. II (1905), t. 519 (genus *I. lacustris*). — Exs.: Rabenh. Crypt. vascul. Europ. No. 76; HFR No. 1549.

Perennial, 3—10 (15) cm high, with pale green often arched-recurved leaves to 0.5—2 mm long; macrospores covered with slender sharp brittle echinules; microspores faintly reticulate. July–September. (Plate VI, Figure 24).

Lake bottoms. — European part: Kar. -Lap., Lad. -Ilm., U. V., V.-Kama (lower part). **Gen. distr.**: Arctic (?), Scand., Centr. Eur., Atl. Eur. Described from Centr. France.

3. **I. asiatica** Makino in Tokyo Bot. Mag. XXVIII (1914) 184. — *I. echinospora* var. *asiatica* Makino in Tokyo Bot. Mag. XVIII (1904) 18.

Perennial, 3.5—15 cm long; leaves dark green, erect or somewhat spreading, 1.5—2.5 mm in diameter at the middle, gradually tapering, paler toward base; macrospores sharply echinulate, the echinules stouter than in the preceding species; microspores smooth. July–September. (Plate VI, Figure 26).

Lake bottoms and shores. — Far East: Kamch., Sakh. **Gen. distr.**: Jap. -Ch. Described from Lake Nojiri in Shinano Province* (Japan). Type in Japan.

4. **I. beringensis** Kom. in Bull. d. Jard. Bot. d. l'Acad. d. Sc., d. l'USSR XXX, 1—2 (1932), 196.

Perennial, ca. 10 cm high; leaves light green, paler toward base, long-tapering, thickish, rather strongly spreading, with numerous stomata; macrospores whitish, smaller than in the three preceding species, covered with short obtusish spinules rather with warts. August–September. (Plate VI, Figure 25).

Lake bottoms and silty lake shores. Far East: Komandorskie Is. Type in Leningrad.

Division II. **EMBRYOPHYTA — SIPHONOGAMA**

Embryophyta Siphonogama, i. e., plants furnished with a developed embryo and pollen tubes. (They are also referred to as siphonogams, anthophytes, flowering plants, seed plants, or spermatophytes.)

Plants of this group consist of root, stem, leaves, flowers, and fruits; the seeds contain under their coat an embryo and endosperm or embryo
129 alone, this consisting of a radicle, gemmule, and cotyledons. All parts, except the anthers and the embryo sacs, are composed of cells containing a double set of chromosomes in their nuclei. Plants containing such diploid nuclei are called diploid plants or sporophytes. They propagate vegetatively by means of vegetative buds, suckers, offsets, etc., and reproductively by seeds. Formation of microspores is initiated by

* [Now Nagano prefecture.]

division of the inner tissue of the anthers by so-called reduction division involving halving of the chromosome number in the nuclei of the young cells. The pollen grains thus have a nucleus in which the number of chromosomes is half that of the cell nuclei of the plant itself. While growing in drops of nectar they produce a pollen tube of varying length. Two nuclei of the "microgamete," that form in the pollen tube, in addition to the proper vegetative nucleus, correspond to spermatozoids of animals. In the ovary of the flower we encounter ovules that contain the embryo sac which is also a product of reduction division and, together with pollen, constitute the haploid generation of the plant. The embryo sac contains both cells corresponding to the prothallium of pteridophytes and embryonic nuclei corresponding to the oosphere nucleus of pteridophytic archegonia.

Subdivision I. **CYMNOSPERMAE**

Ovules naked, borne terminally on the plant axis or on cone scales; styles and stigmas absent; a multicellular tissue developing in the embryo sacs still before pollination, this tissue forming the endosperm by accumulation of storage materials; in its upper part develop archegonia which consist largely of the embryonal nucleus; flowers unisexual, without perianth; staminate flowers gathered in spikes [aments], the pistillate in cones; pollination by wind. Plants exclusively woody. The subdivision contains seven* classes, of these only two in USSR.

Class **CYCADACEAE**

Family **CYCADACEAE** LINDL.

Genus **CYCAS** L.** 1737

C. revoluta Thunb. Fl. Jap., 1784, 229. — Stem erect, stout, 1 to 2 m tall, covered with woody scales (remnants of fallen leaves); leaves all terminal, dark green, rigid, pinnate, 0.6–2 m long; leaf segments entire, linear, acute; staminate cones erect; stamens with numerous pollen sacs on the undersurface; carpellary leaves solitary, in the axils of upper foliar leaves, slightly pinnatisect, densely covered with brown tomentum, bearing 2–8 red ovules on the margins.

130 Originating from the S. part of Japan. Introduced into Europe in 1737. In the USSR, cultivated in the open in gardens of the Caucasian coast, from Sukhumi to Batumi, where it fruits.

Note. Cut cycas leaves are ornamental and are used at funerals, etc. The plant is cultivated in the fields of S. Japan for the starch stored in the pith.

* Cycadofilices (extinct), Bennettitales (extinct), Cycadales, Ginkgoales, Cordaitales (extinct), Coniferae, and Gnetales.

** Arranged by V. L. Komarov, except Gnetales which see on page 154.

Class GINKGOALES

Family GINKGOACEAE ENGLER

An extinct family. The genus *Ginkgo* existed on USSR territory at least since the Trias, reaching efflorescence in the Jurassic flora of Siberia. Only one species occurs in the Tertiary flora of the USSR, namely *G. adiantoides* Brgt., related to the contemporary Sino-Japanese *G. biloba* L.; it has been found in the following locations: in Aquitanian layers of Ufimsk District near Sterlitamak; in Sarmatian formations of N. Caucasus (Krymskaya); in Ussuri Territory (Pos'et, Novokievsk, Sikhote-Alin, Amagu), DeVries and Rechnoi peninsulas; in Sakhalin, in layers of the upper Due series at Aleksandrovka, Mgachi, Vladimirovka, Ogorodnaya Pad, Cape Rogatoi, etc. In addition, *G. adiantoides* was discovered near Astashikha at mouth of Bureya (Amur region) in layers of the upper Pliocene, and *G. reniformis* Heer. in Tertiary formations of Lena-Kol. (Chirymyi-khaya in Yakutia).

The only extant *Ginkgo* species, *G. biloba* L. produces fairly large trees on the Black Sea coast of W. Caucasus, and occasionally on the S. coast of Crimea. Dioecious, to 30 m tall; seeds edible.

Class CONIFERALES

Order 1. Coniferae

Staminate and carpellate cones terminal or rarely axillary, subtended by scales; microsporophylls (stamens) flat or shield-shaped, mostly with 2 or rarely many (to 20 in *Araucaria*) sporangia (anthers); carpellate flowers forming cones with numerous carpels, rarely reduced to few or even to a solitary carpel, very rarely carpels none and ovules borne at the end of the branch (in the yew family); carpels simple or with a process parallel to its plane and then differentiated into an ovulate scale and bract, ovules on carpels solitary or in pairs (in *Pinaceae*), or several, with a single coat; seeds varying in shape, winged or wingless; cotyledons 2–15. Axial organs with annular cambium; secondary wood consisting of tracheids, without a proper vascular system; pith undeveloped. Seven families*, of these three in the USSR.

1. Fruit a true cone, with numerous woody scales; leaves needlelike
Family XII. **Pinaceae** Lindl.
- 131 + Fruit different, sometimes berrylike; leaves needle-shaped in whorls
of 3, or linear-lanceolate, or scalelike 2.
2. Seeds solitary, surrounded by a fleshy red cup-shaped aril; leaves
linear-lanceolate, arranged in one plane, apparently 2-ranked
Family XI. **Taxaceae** Lindl.
- + Fruit berrylike, red or black, with glaucous bloom, or else dry, opening
into 2 or 4 valves; leaves in whorls of 3 or scalelike and decussate . . .
Family XIII. **Cupressaceae** F. W. Neger.

Family XI. TAXACEAE LINDL.

Staminate cones solitary, in the leaf axils; microsporophylls (stamens) with 2–8 sporangia (anthers) each; ovulate flowers at the ends of short axillary branchlets subtended by several pairs of scalelike bracts; ovules

* Taxaceae, Podocarpaceae, Araucariaceae, Cephalotaxaceae, Pinaceae, Taxodiaceae, and Cupressaceae.

solitary, with a single coat; seeds surrounded by a fleshy aril. Much branched trees or shrubs, with evergreen needlelike leaves. Anemochorous, pollinated in early spring, ripening the same year, the seed continuing to grow for 2 years after ripening. Three genera and 13 species, of these 12 in the Northern Hemisphere and one in New Caledonia.

Genus 37. **TAXUS** * L.

L. Gen. pl. (1737) p.312.

Trees or shrubs; foliage dense, dark green; leaves linear, in spiral arrangement, but spreading in a single plane by flexion of the short petioles.

Taxus baccata L.—In interglacial formations of U.V. (Likhvin); *Taxus* cf. *baccata* L.—remnants in Sarmatian layers of L. Don (Krynka).

1. Leaf tips short-acuminate, minutely mucronulate. . . . 1. *T. baccata* L.
+ Leaf tips abruptly cuspidate. 2. *T. cuspidata* Sieb. et Zucc.

1. *T. baccata* L. Sp. pl. (1753) 1040; Pall. Fl. Ross. II, 17; Ldb. Fl. Ross. III, 666; Beissner Nadelholzkunde 3 Aufl. 36; Medv., Der. Kavkaza, 2 ed., 45 with plate; Vul'f, Fl. Kryma 1, 32; Fom., Vseukr. Akad. N., Trudy Fiz. Mat. Vidd. 1928, 9. Russian: tis yagodnyi or negnoi-derevo; German: Gemeiner Eibenbaum, Eibe, Taxusbaum, Taxbaum; French: if commun; English: common yew; Italian: tasso, libo; Czech: tis; Hungarian: tistsafa; Latvian: eglus; Georgian: utkhovari, sadzhi; Imeritian: urtmela; Armenian: sochni, keni; Tataric: kizil-agach; Ossetian: zaz; Abkhazian: aa.

- 132 Perennial; tree to 20 m tall and ca. 1 m in diameter; bark reddish-gray, smooth or flaky; leaves to 3.5 cm long and 2 mm broad, dark green and lustrous above, pale and dull beneath, the margins slightly revolute; fruits red, globose, open at the top; seeds very hard, ovoid, brown, with small spots; fleshy aril bright raspberry-colored, juicy, sweet-tasting. March-May.

European part: in Crimea, only in beech woods and inaccessible places in Yaila; Caucasus: in mountain woods, nearly everywhere except Dagestan and Erevan, particularly abundant in Abkhazia, from the seashore up to 1700 m above sea level. ** **Gen. distr.** : in Europe, from England, Norway and Sweden to Estonia and Brest-Litovsk, and southward to N. Africa.

Note. According to Fomin, the Caucasian yew (var. *caucasica* Fom.) differs from the European in having more loosely leafy branches, longer middle leaves terminating in a longer mucro, and the more coriaceous bud scales membranous-margined. In Crimea, according to Vul'f, the leaves of var. *communis* Sen. do not exceed 2 cm in length, while yew leaves in Europe are 3.5 cm long and 2 mm broad. It grows in damp shady woods, with preference for beech woods.

Economic importance. The fine-grain yellowish-red or brownish-red wood, with a rather narrow layer of white or yellowish sapwood, is very hard and durable. It provides good material for carpentry and turning. The bitter bark yields a glue used for bird catching. The bitter leaves are deadly poisonous to horses, cows and goats; they find use in popular medicine against hydrophobia and heart ailments. The fruits are edible.

* Latin name of this tree, referring to its toxic properties.

** An insular habitat of yew occurs in Lenkoran. According to N.V. Shipchinskii, this yew differs from the common Caucasian yew.

Deserves more extensive planting. Propagated by seed, cuttings, and offshoots. A useful ornamental tree for home and public gardens in the South.

Yew is the only conifer that does not contain any resin at all; it contains an alkaloid "taxin," $C_{37}H_{51}NO_{10}$ and a stimulant essential oil.

2. **T. cuspidata** Sieb. et Zucc. Fl. Jap. fam. natur. II, 108 et Fl. Jap. tab. (1842) 128; Miyabe and Kudo Fl. of Hokkaido and Saghalien, I, 68.—*T. baccata* var. *microcarpa* Trautv. in Maxim. Prim. Fl. Am. (1859) 259; Fr Schmidt Fl. Sachal, 175.—*T. baccata* subsp. *cuspidata* Pilger in Engl. (Pfl. -Reich IV, 5 (190), 112).—Russian: *Tis yaponskii* [Japanese yew]; Japanese: *ishin*, *araragi*, *onko*; Ainu: *raramani*, *taramani*.

Perennial; a tree or shrub, to 12 m tall and 1.5 m in stem diameter; leaves to 2.5 cm long and somewhat more than 2 mm broad, round-tipped and produced into a short cusp; seeds slightly flattened, 5—5.5 mm long and 1.5 mm in diameter. In other characters resembling the preceding species. June, July. (Plate VIII, Figure 10).

133 Far East: the banks of Amur in its lower reaches (shrubby form), in the forests of Sakhalin and Ussuri Territory as single trees but not infrequent. **Gen. distr.:** Kurile Is., Japan, Formosa, and Korea (14 locations), Manchuria, and China. Everywhere in mountain woods.

Economic importance. The wood is valued for carpentry ("red" or "pink" wood). Cultivation recommended for commercial purposes.

Family **PODOCARPACEAE** F. NEGER

Genus **PODOCARPUS** * L. HÉRIT

A genus represented only by fossil species: in the lower Tertiary formations of the European part of the USSR the following finds: *Podocarpus Apollinis* Ett. in the Oligocene of M. Dnp. (Ekaterinopol'e); *Podocarpus eocenica* Ung. in the Oligocene of Bl. (Kremnevaya Ravine in former Mariupol' County) and M. Dnp. (Ekaterinopol'e), in the Paleocene of L. Don (Osinovka in Kharkov area), and in Tertiary layers of Transcaucasia (Ararat).

Family **ARAUCARIACEAE** STRASBURGER

Genus **AGATHIS** ** (DAMMARA † L.) SALISBURY

The following species are known in fossil condition: *Dammara Armaschewskii* Schmalh. from the Oligocene of M. Dnp. (Mogil'no in Volhynia) and *Dammara Tollii* Schmalh. from Tertiary formations of Arc. Sib. (Novosibirskie Is.).

Genus **ARAUCARIA** †† JUSSIEU

Solely in fossil condition, the only known finds consisting of wood fragments of *Araucaria dixylon* sp. from the Pliocene of W. Transcaucasia (Goderskii Pass).

* From Greek *pūs*, foot (in genitive inflection *podos*) and *carpos*, fruit.

** From Greek *agathas*, clew, heap, referring to the crowded staminate aments.

† From *dammār*, Malayan name of the tree.

†† From local Chilean name of this tree.

Family XII. **PINACEAE** LINDL.

- Staminate cones with a whorl of scalelike bracts at base; microsporophylls numerous, each bearing 2 microsporangia with lateral air sacs; carpellate cones with numerous spirally arranged bract scales, the ovuliferous scales borne on the upper surface of the bracts, either adnate to their base or free; ovules in pairs, borne symmetrically on the upper side of the scale, the micropyle directed downward; mature cones becoming woody, remaining closed and greatly increasing in size; bracts more or less lagging behind in growth, always narrower and thinner than the ovuliferous scales; embryo with numerous cotyledons; endosperm large, rich in proteins and fats. Trees or rarely shrubs, with needle-shaped spirally arranged leaves; roots with mycorrhiza; anemochorous, diclinous, monoecious plants. Of the 9 known genera and some 250 species, most grow in mountain woods in the warmer part of the Northern Hemisphere Temperate Zone, many occur in China and in the U. S. A.
1. All shoots long, with spirally arranged leaves 2.
 - + In addition to long spring-produced shoots, there are short lateral summer-produced spurs terminating in leaf pairs or fascicles 3.
 2. Cones erect, the scales falling separately at maturity; bracts developed in ripe cones; abscission-scars round, flat, without pulvini 38. **Abies** Hill.
 - + Cones falling at maturity, with persistent scales; bracts of mature cones reduced; abscission-scars with prominent oblong pulvini 39. **Picea** Link.
 3. Leaves of spurs in dense tufts, soft, annual, deciduous in fall; cones small, maturing through one summer 40. **Larix** Miller.
 - + Leaves of spurs in pairs or in clusters of 5, all evergreen, stiff; cones large, taking 2 to 3 years to ripen 41. **Pinus** L.

Genus 38. **ABIES** * HILL.

Hill. Brit. Herb. (1756) 50.

Evergreen trees; bark of young trees smooth, light gray, with planiconvex vesicles containing liquid resin, in older trees wrinkled, with longitudinal fissures; leaves spread out in one plane or all around the branch, those on the upper side erect, mostly forming 2 ranks, linear, flat, very shortly petioled, the underside nearly always with two white waxy bands containing the stomata; leaves of fertile branches 4-angled, with stomatic bands on each of the four angles; leaf margins slightly revolute; resin ducts internal or marginal, or above and below the vascular bundle forming the midnerve; cones monoecious; staminate cones ovoid or cylindric-oblong, with yellow or red anthers; ovulate cones ovoid or oblong, erect, the seeds falling away at maturity together with the ovuliferous scales, the cone-axis persistent on the tree; there are no cones to be found under the tree, only separate scales; cotyledons 4-10. The genus contains 45 species.

* Old Latin name for fir [Russian "Pikhta"].

- The following species have been reported from Tertiary formations of the USSR: *Abies alba* Mill. from Alt. (Chingistai); *A. carbonaria* Rogowicz from the Eocene of M.Dnp. (Kiev); *A. (Tsuga?) Dolinskii* Schmalh. from the Oligocene of M.Dnp. (Ekaterinopol'e); *A. cf. Macclurii* Heer, from the Oligocene of Uss. (Amagu); *A. paleocenica?* Krassn. from the Paleocene of V.-Don (Siyaz); and *Abies* sp., without specific name, from Tertiary layers of Balkh. (Ashutas) and Post-Pliocene of U.V. (Likhvin).
1. All leaves entire at apex, spiny-pointed 2. ***A. holophylla*** Maxim.
 - + Leaves of lateral branches emarginate or even bifid at apex; leaves of terminal and fertile branches short-pointed, entire 2.
 2. Tips of cone bracts long, recurved, very conspicuous 3.
 - + Tips of cone bracts short, completely hidden or but slightly exerted from behind the ovuliferous scales 6.
 3. Buds ovate, not resinous 4.
 - + Buds round, amply covered with resin 5.
 4. Leaves pectinately arranged in one plane or in V-shaped arrangement; cones relatively slender, 3—5 cm in diameter; bracts flat about the tip ***A. alba*** Mill.
 - + Leaves not pectinately arranged, closely approximate, along the center of the branchlet directed forward, forming scaly ranks, on the lower side of the branchlet in two lateral ranks; cones broader, ca. 5 cm in diameter; bracts about the tip emarginate 1. ***A. Nordmanniana*** (Stev.) Spach.
 5. Leaves as in *A. Nordmanniana*, 2.8 cm in length; ovulate cones 6—8 cm long; bracts point-tipped, the tip longer than the broad free portion 6. ***A. sachalinensis*** Mast.
 - + Leaves 1.5—2.5 cm long; cones oblong-ovoid, 3.5—6 cm long; tip of bracts shorter than the broad free portion ***A. Fraseri*** Poir.
 6. Leaves to 3—5 cm long; upper margin of ovuliferous scales uneven, apiculate; bract half as long as the scale 7.
 - + Leaves shorter; upper margin of ovuliferous scales regular, not apiculate; bract two-thirds as long as the scale 8.
 7. Leaves to 4 cm long, rather soft; growing in Soviet Central Asia 4. ***A. Semenovi*** Fedtsch.
 - + Leaves to 3 cm long, rather firm; growing in Siberia, Urals, etc. 3. ***A. sibirica*** Ldb.
 8. Leaves 2—3 cm long; cones 6—10 cm long, their scales without conspicuous pubescence 5. ***A. nephrolepis*** Maxim.
 - + Leaves to 2 cm long; cones 2.5—3 cm long, reniform, their scales densely covered beneath with reddish hairs 7. ***A. gracilis*** Kom.

A. alba Mill. Gard. dict. ed. 8 (1786) No. 1; Asch. und Gr. I, ed. 288; Shmal'g. 671. — *A. pectinata* DC. Fl. Fr. III (1805) 276. — *Pinus picea* L. Sp. pl. (1753) 1420; Ldb. Fl. Ross. III, 669. — *A. picea* Lindl. in Benny Cyclop. I, 1833. Russian: pikhta evropeiskaya [European]; German: Weisstanne; English: common silver fir; French: sapin de Lorraine; Polish: swierk, hence Russian vernacular svirka or shmerka; Ukrainian: smereka bila.

Perennial; tree 30—65 m tall, the trunk 2—5 m in circumference; bark whitish-gray, long retaining its smoothness; top pyramidal to cylindric, with horizontally spreading branches; young branches densely clothed with short stiff hairs; leaves of sterile branches pectinately spreading, 3 cm long, 2—3 mm broad; cones initially pale green, becoming brown, to 16 cm

long; bracts exceeding their scales, terminating in a rather long recurved point; seeds 3-angled, dark, broadly winged, the light-colored wing twice the length of the body.

In pure stands or together with spruce and beech, chiefly on argillaceous and calcareous soils. Distributed through Centr. and S. Europe, the western limit being in Poland at 24° E. long., the northern limit lying at the 52nd parallel. Small disjunct concentrations are located in Bialowieza Forest and Volhynia. Described from Switzerland. Type in London.

Economic importance. Valuable forest trees, yielding valuable timber. The wood is readily workable and, owing to its resonance, it is used for musical instruments. It contains little resin, but it is more durable than spruce wood; it produces the so-called Strasbourg turpentine. In the USSR only cultivated. In the Moscow area it does not survive the winter above the snow level. R. I. Schroeder (Mitt. d. Deutsch. dendr. Gesellsch., 1899, 121), however, described a climatic race, var. *podolica*, which, according to his claim, does not freeze. Shesterikov reported (Opr. rast. okh. Odessy, [Key to the Plants of the Odessa Region], 1912, 29) that it is grown in parks and gardens.

1. **A. Nordmanniana** (Stev.) in Spach Hist. veget. phaner. XI (1842) 418.—*Pinus Nordmanniana* Stev. Bull. Soc. nat. Mosc. (1838) 45, tab. 2; Ldb. Fl. Ross. III, 670.—*Picea Nordmanniana* Loud, Encycl. of Trees 1042, f. (1842) 1950.—*Pinus picea* β *leioclada* (Steven) Ldb. Fl. Ross. III, 669.—Russian: *pikhta kavkazskaya* [Caucasian] or *Nordmannova* [Nordmann's]; German: *Nordmannstanne*; Georgian: *sotchi*; Armenian: *egevin*; Abkhazian: *amza*; Circassian: *psei*; Svanetian: *nenze*.

A strong, outstandingly beautiful tree, up to 50 m tall and 1.5 m in diameter; top pyramidal, becoming slim, almost cylindric (except the summit); bark gray, firm, with shallow fissures; young branches reddish, with rufous pubescence, rarely glabrous; buds scantily resinous, dry; 137 leaves 2—3.5 cm long, round-tipped, bifid at apex, very densely covering the branchlet; cones solitary at the ends of upper branches, oblong-cylindric, brown, 12—15 cm long; bracts with a rounded broad denticulate-margined apex, the slender recurved tip-point arising on the outside; seeds yellowish, oblong-cuneate, tuberculate-angled, 10 mm long, broadly winged, the thin light brown wing 2—3 times the length of the body.

This fir grows best in deep fissures with humid air, where it becomes established on crests and slopes, avoiding waterlogged soils. Deep soil, rich in humus, is essential. Owing to the deep root system, this tree is seldom uprooted by wind. Caucasus: in mountain woods of Kuban, W. Transc. and Centr. Cauc. along the upper course of streams, tributaries of Kuban, Rion and Kura rivers, in the zone between 1320 and 1950 m; only along Kura coming down to 900 m. In the mountains of Adzharia, Abkhazia, Svanetia and Imeritia there are pure stands of fir; more often it occurs together with spruce and beech. The southern limit is marked by the left tributaries of the Chorokh and by the Pontic Range, which is already in Turkish territory. The eastern limit runs from Svanetia to the watershed between the Kuban and Terek rivers. In the Greater Caucasus area, the eastern limit lies in Ossetia and along the Liakhva R. The best developed and almost pure forests of Caucasian fir occur on the E. slopes of the Greater Caucasus, in the upper reaches of rivers which reach the sea between Tuapse and Sukhumi. The SE limit is in Turkey. Described from Adzharia (sources of Kura River). Type in Helsinki.

Note. The degree of hairiness of the shoots varies. According to Medvedev (Der. i Kust. Kavkaza, Ed. 2, 1905, 22), the branches of some trees are densely hairy, while those of others are practically glabrous. Steven (Bull. Soc. nat. Mosc. 1838, 44) described branches destitute of pubescence under *Pinus leioclada* Stev., as representing a distinct species.

Economic importance. Oldest trees reach an age of 500 years and yield about 40 cubic meters of white or somewhat reddish, soft, light, resilient, durable, easily workable wood. Forests of this fir are a source of construction and carpentry timber. The bark yields turpentine. The needles contain an essential oil. The Caucasian fir was discovered by Nordmann in the Adzhar Range and already in 1840 was introduced into cultivation in Europe. It is highly valued for planting in gardens and parks. Being branched from base, it is outstandingly ornamental. It seeds itself often and profusely and in its native region the seedlings densely cover thinned-out stands. Fairly frost-hardy, as damage by late frosts is confined to very young shoots.

2. **A. holophylla** Maxim. Mém. Biol. Acad. Petrop. VI, (1866) 22; Kom. Fl. Mansch. I, 204; Beissner, Nadelholzkunde, 3 Aufl., 133.— *Pinus holophylla* Parl. in DC Prodr. XVI, 2 (1868) 424.— *A. firma* Masters in Journ. Linn. Soc. XVIII, (1881) 514, non Sieb. et Zucc.

138 Tree to 45 m tall; bark dark gray, uneven, longitudinally fissured; top pyramidal; young branchlets pubescent; leaves larger than in our other fir species, flat, firm, spiny-pointed, 2–2.5 cm long, 2 mm broad; cones ovoid, 8 cm long, 5 cm thick, obtuse; ovuliferous scales cuneate-cordate, broad, the margin entire or slightly crenulate; bracts very short; seeds cuneately obovate, the wing as long as the body.

Grows together with Korean cedar in mixed forests of the Manchurian type, on mountain slopes up to an altitude of about 500 m.— Far East: the northern limit runs approximately from Suchan Valley to Sungari River near Harbin; westward spread to Kirin; southern limit in the mountain woods of Korea. The general northern limit of the distribution area attains 38°N. lat. In addition, the species finds refuge on 11 disjunct mountain peaks in Korea. The southernmost outpost is located in the forests of Quelpart I. [Cheju], at 33°25'N. lat. Described from the surroundings of Vladivostok. Type in Leningrad.

Economic importance. Wood soft, but, in spite of the large size of the trees, of little value; suitable for pulping, its color yellowish or reddish-white. Bark yielding resins. In cultivation in England and America since 1905.

A. Fraseri (Pursch) Poir. in Lam. Encycl. Suppl. 5 (1817), 35.— *Pinus Fraseri* Pursch Fl. Bor. Am. (1814); 639.— Russian: pikhta *Fraseri*; English: double balsam fir.

Tree to 25 m tall; bark smooth, reddish and scaly in age; buds small, subspherical, resinous; leaves 5–2.5 [?] cm long, lateral pectinate, the terminal forking into 2 ranks; cones oblong-ovoid to ovoid, 3.5–6 cm long; ovuliferous scales with a regular rounded margin, 2 cm broad; bracts oblong-obcuneate, with sinuate crenulate margins, shortly point-tipped, the tip exserted and recurved.

Grows in Allegheny Mountains of North America (the upper mountain zone). Introduced into Europe by Fraser in 1911. Cultivated in Finnish gardens (Melan-Cajander, 26); recorded for the Moscow area by Schrader (Russkii ogorod [The Russian Garden], 1918, 549) as a fully frost-hardy tree for pleasure grounds. Yielding wood and resin.

A. balsamea Mill. Dict. No. 3 (1768); Britton and Brown Ill., Fl. ed. 2, 1, 63. — Russian: pikhta bal'zamicheskaya; English: balsam fir, balm of Gilead fir.

Tree 15–25 m tall, with a narrow pyramidal top; bark smooth, blackish-gray with numerous resiniferous swellings; young branchlets yellowish-brown, hairy; buds round, lustrous, profusely resinous; leaves irregularly 2-ranked, 15–28 mm long, 1.5 mm broad, rounded or erose at apex, characterized by a strong pleasant fragrance; cones rounded-oblong, blunt, 6–10 cm long and 2.5 cm thick, dark violet when young, in maturity grayish-brown, very resinous; bracts fringed-toothed, subulate-tipped; seeds cuneate, 5 mm long, brown, broadly winged, the wing 10 mm long.

139 Native in the forests of N. America, especially in Allegheny and Adirondack Mountains. Introduced into Europe by Compton in 1697. Yields Canada balsam. According to Syreishchikov (Mosk. Fl. I, 58), cultivated in gardens and parks.

3. **A. sibirica** Ldb. Fl. Alt. IV (1833) 202; Beissner Nadelholzkunde, 3 Aufl., 144. — *Pinus picea* Pall. Fl. Ross. I (1784) 7. — *P. pichta* Fisch. ex Lodd. Cat. (1836) 50. — *P. sibirica* Turcz. Cat. Baikal No. 1067 (1838) Ldb. Fl. Ross. III, 669. — *Abies pichta* Forb. Pin. Wob. (1839) 109, tab. 37. — Ldb. Icon. V (1934) 500. — Russian: pikhta sibirskaya; German: sibirische Tanne; English: Siberian silver fir; French: sapin de la Sibérie; Zyrian: niu; Tataric: ak-shersh; Mongolian: khadsura; Tungusic: nankta; Buryat: dzhodo; Bashkirian: ak-chirshe; Ostyak: nolga; Cheremis: nulga.

Tree to 30 m tall, 55 cm in diameter; bark dark gray, smooth; top narrowly pyramidal, with branches from base; young branchlets clothed with brownish hairs; leaves 1.5–5 cm long and 1–1.7 mm broad, rounded or obtuse and shallowly retuse at apex, not stiff; cones ovoid-cylindric, 5–9 cm long and 2–4 cm thick, dark purple when young, light brown in maturity; ovuliferous scales obliquely rounded, minutely crenulate at the margin, velutinous on the outside; bracts one-third as long as their scales; seeds obliquely obovate, 7 mm long, slightly pubescent, the semiobovate wing 8–10 mm long and 7–8 mm broad. (Plate VII, Figures 5–8 and Plate VIII, Figures 1 and 2).

European part: from Mezen R. and Severnaya Dvina (village of Emtsa), Sukhona, Vetluga, through Urals and Siberia, to Stanovoi Range, mostly together with spruce, rarely in pure stands (these called pikhtachi or chern'). The spruce is one of the widespread taiga trees. The northern limit attains 67°40' N. lat. in the lower reaches of the Yenisei, further to the east it falls back to the south and cuts across the Middle [Podkammenaya or "Stony"] Tunguska near Erbogochon village at 61° N. lat. and across Lena and Nokhtui at the 60th parallel; the most northerly point in the upper reaches of the Aldan lies at 57°40'. The eastern limit runs from the Vitim Plateau, along Stanovoi Range in Transbaikalia and the Buryat-Mongol ASSR, into Mongolia, to upper reaches of the Onon R. and Ire, continues along the

Sayans (Irkut R.) and the tributaries of the Yenisei in Tannu-Tuva [Tuva Autonomous Region], then from the Kom and Kanas rivers in the Mongolian Altai to the Dzungarian Ala Tau, where it still forms forests in the Kora R. valley. In Urals, the limit of distribution attains its southernmost outpost at the village of Sedyachev, at 55°35'N. lat., where it swerves northward toward Kurgan and northwestward toward Kazan. Described from Altai. Type in Leningrad.

Note. The Siberian fir apparently attains its most luxuriant development in Altai, where it forms vast dense impenetrable forests ("chernevye" forests) between the Katun R. and Lake Teletskoe (Kuznetsk Ala Tau). It also grows profusely along the Bukhtarma R., in the Kholzunskii Range, etc. There is also a dwarf form of high mountains, f. *alpina* Poljakov, with thick leaves and round cone scales. In the mountains Siberian fir nearly reaches the timberline, rising to 2000 m. In the plains (Tobol'sk) it prefers clayey podzols.

Economic importance. The wood is light and soft, without heartwood and resin ducts. Its practical value is almost nil. It would probably give 140 good paper pulp and the bark could yield turpentine. The foliage contains up to 2% of essential oils and the seeds up to 30% of fatty oil suitable for varnish production. Young twigs contain borneol or borneo-camphor. One of the most shade-resistant trees. Introduced into cultivation as a pleasure-ground tree as early as 1820. Grows well in cool and humid climate and stands up to severe frost. Growth is slow. Cultivated also in the USSR and sometimes becomes naturalized (Shlisselburg [Petrokrepost] area).

4. **A. Semenovi** Fedtsch. Bot. Zentralbl. (1898) No. 7; Mitth. d. deutsch. dendrol. Ges. (1898) 29 und (1903) 63; Rast. Turkest. (1915) 34.—
A. *sibirica* Ldb. ex Litw. et Korsh. in HFR No. 649; Beissn. Nadelholz. 3 Aufl., 144.

Very closely related to A. *sibirica*. In the words of B. A. Fedchenko, "it is distinguishable by its longer needles, up to 40 cm long, and their anatomical structure, i. e., the absence of mechanical elements over a considerable area"* (at base).

Central Asia: It grows in the mountain forests of the Talass Ala Tau and the Satkal'skii Range (Aflatun, Pasha-ata, Khodzha-ata and Sary-chilek passes, etc.). As compared to the Siberian fir, it has a disjunct distribution (between the Dzungarian and Talass Ala Tau ranges there is an expanse of more than 600 km of woodless lowlands of the Balkhash Plain). Described from the Bishtash R. in the Talass Ala-Tau. Type in Leningrad.

Note. While studying material relating to this species, Petunnikov (Trudy Yur'evskogo Bot. Sada, 60. 1900) established its identity with Siberian fir; however, the milder climate of Fergana Mountains undoubtedly found expression in the softer and longer foliage.

Economic importance. B. A. Fedchenko considers this fir to be a good construction timber.

5. **A. nephrolepis** Maxim. Mél. Biol. Acad. Petrop. VI (1866) 21; Kom. Fl. Mansh. 1, 200; V. F. Ovsyannikov, Khvoinye porody [Coniferous Species] (1930) 35.—A. *sibirica* var. *nephrolepis* Trautv. in Maxim. Prim. (1859) 260.—A. *sibirica* Korsh. AHP XII, 424.—A. *Veitchii* Lindl.

* As I have often observed, this character applies equally to Siberian fir, and it distinguishes both species from the European fir in which the hypoderm is uniformly developed. B. K.

var. *nephrolepis* Masters in Journ. Linn. Soc. XVIII, 516.— Russian: pikhta pochkocheshuinaya, belokoraya [white-barked] or amurskaya [Amur fir]; German: mandschurische or nierenschuppige Tanne; Gilyak: ngarin; Goldi: vankta.

Tree to 20 m tall; bark very light colored, smooth; top dense, pyramidal, dark green; young branchlets pubescent; leaves 1–2 cm long and 1.5 mm broad, slightly bifid at apex; anatomically it differs from
 141 Siberian fir that has no mechanical elements under the leaf epidermis or in the midrib, in showing clearly in cross section a large group of thick-walled cells below the nerve and a small group above it; single layer clusters of such cells are also distributed below the epidermis except at the site of the stomata; cones cylindric to ovoid-cylindric, dark violet, at length becoming brown, 5–6 cm long and 2–2.5 cm thick; ovuliferous scales reniform; bracts shorter than their scales including tips; seeds cuneate-ovate, the wing shorter than the body.

Growing together with *Picea jezoensis* in mountain woods.— Far East: the whole of Sikhote-Alin, in the Bureya Mountains and from the shores of Tatar Strait westward to the Sungari R., reaching beyond it only in the mountains of Lesser Khingan to 127°. To the south, it penetrates into the E. part of Mukden Province [former Liaoning Province?], to 41°N. lat. In the mountains of Korea along the Ueki R., a solid expanse of mixed forest with *A. nephrolepis* stretches in the north from the 42nd to the 40th parallel, while further to the south there are 12 disjunct mountain concentrations of fir-and-spruce forest right up to 35°25' N. lat., the southern outposts almost on the Korean Peninsula itself. The northern limit runs from the Tukuringra Range along Zeya R. to the seashore north of Nikolaevsk. In the north this fir may be encountered already at sea level, while in the south it forms the upper mountain zone. Described from the lower reaches of the Amur. Type in Leningrad.

Economic importance. The wood of this fir is soft and of little value. It should provide good material for paper pulp. It is very rarely found in cultivation, except in botanical gardens.

6. *A. sakhalinensis* Mast. in Gard. Chron. (1879) 588 cum ic.; Miyabe and Kudo Fl. Hokk. and Saghalien, I (1930) 75.— *A. Veitchii* Lindl. var. *sachalinensis* Fr. Schmidt Fl. Sachal. 175, t. 4, f. 13–17.— *A. Veitchii* Mast. var. *nemorensis* Mayr Abietin. Japon, 43, t. 3, f. 6.— *A. akatoto* Miyabe apud Sarg. Gard. and For. VI, 525.— Russian: pikhta sakhalinskaya; Japanese: todomatsu or akatodo; Ainu: khup, yayup; Gilyak: n'yarngi; Oroch.: vangita.

Tree to 40 m tall; bark light gray, smooth; top pointed; young branches densely clothed with short pubescence; buds small, round, resinous; leaves soft, to 4 cm long, obtusely rounded at apex, retuse; cones cylindric, somewhat attenuate toward apex, 6–8 cm long and 2.5–3 cm broad; bracts broadly reniform, hairy; ovuliferous scales membranous, round, toothed-margined and point-tipped, recurved above the bracts; seeds 5 mm long, angled-cuneate, broadly winged, the truncate grayish-violet wing as long as the body.

Far East: Sakh. **Gen. distr.** : southern Kurile Is. and Hokkaido. Described from W. and S. Sakhalin. Type in Leningrad.

Economic importance. Used like other firs. Introduced into cultivation in 1879 as a handsome and hardy tree for pleasure grounds.

- 142 **A. gracilis*** Kom. Fl. Mansh. I (1901) 203; Fl. Kamtsch. I, 98; Mitt. d. d. dendr. Gesellsch. (1903) 62; Beissner, Nadelholzkunde, 2 Aufl., 187. *Picea*, Kraschennikov, Opisanie Kamch. [Description of Kamchatka], I, 44, 191.

Tree to 15 m tall; top dense, ovoid-pyramidal; bark smooth, gray; leaves 1—3 cm long and 0.5—0.2 [?] cm broad; cones 2.5—5 cm long, subcylindric; ovuliferous scales reniform, velutinous below; bracts long-pointed, shorter than their scales; seeds as long as their wings, truncate at the top. — Only a single wood of this fir is known, on low hills along the southern shore of Lake Semyachinskoe on east coast of Kamchatka, whence described. Type in Leningrad.

Genus **TSUGA** CARR.

In the USSR only in fossil condition. Reported from Tertiary formation: *T. Schmidtiana* Palib., from Uss. (Sikhote-Alin), whence a sample is recorded without a specific name; *Abies Dolinskii* Schmalh. possibly also belongs to the genus *Tsuga*, but the available remnants are not sufficiently reliable. In our time tsugas grow in forests of N. America and in W. China.

Genus 39. **PICEA** ** DIETRICH

Dietrich, Flora d. Gegend von Berl. (1824) 479.

Evergreen trees, with branches arranged in more or less regular whorls; leaves 4-angled, with white stomatic bands on all four sides, or flat and then stomatic bands confined to the lower [?] side; petioles adnate to branchlets, forming prominent pulvini, these extending along the branchlet and jointed, the leaf blade falling at the joint and leaving a characteristic scar; flowers unisexual; stamens in staminate cones [aments]; carpellate cones persistent for two years, then opening to shed the seeds and later falling in their entirety; seeds winged. Up to about 50 species in all, in mountain forests of the Temperate Zone, a few penetrating into the northern plains. In the USSR 7 clearly defined species, two closely related species of the first group, and at least three cultivated species.

Economic importance. The wood is characterized by the absence of heartwood and low specific weight. It is easily worked and sawn. The roots grow horizontally in the superficial soil layer and spruces are therefore easily uprooted by winds.

- 143 Spruce fossils have been reported from various parts of the USSR, mostly remnants of cones: *Ledl. Piceostrobus Neustruevi* Palib. in the Oligocene of the S. Maritime Territory; *Picea anadyrensis* Kryshch. — in the Pliocene or post-Pliocene of the Anadyr area; *P. excelsa* Link. in the Pliocene of the Altai region (Chingistai); in Interglacial formations of U. Dnp. Prechistaya, Vyshgorod, Smolensk and Minsk areas, U. V. (Likhvin, city of Kostroma); *P. ovata* in Interglacial formations of U. V. (Likhvin, Troitskoe); *P. Omalii* Ung. in the Eocene of M. Dnp. (Kursk area, Lava); *P. Wollasowiczii* Sukacz. in early

* According to Beissner-Fitschen, Nadelholzkunde, 1930, 134, synonymous with *A. nephrolepis* Max. in fact, more closely related to *A. sachalinensis* Mast, and possibly represents an isolated colony of this species.

** *Picea*, an ancient Latin name of spruce, derived from the word *pix*, pitch.

post-Pliocene of Lena-Kol. (Aldan) and Arc. Sib. (Omoloi); *P. orientalis* Link. in upper Pliocene of W. Transc.: Georgia (Shirak area); *P. jezoensis* Carr in the Pliocene of Kamchatka. Unnamed *Picea* sp. have been reported from Sarmatian formations of Crimea (Akhtiar) and from the post-Pliocene of U. V. (Likhvin), V. -Kama (Galich), and Lad. -Ilm. (Luga?).

1. Leaves 4-angled, with stomatic bands on all angles (Section *Eupicea* Willkm.) 2.
- + Leaves of ordinary branches flat, pointed, with 2 white stomatic bands on the upper side, this usually turning downward by curvature of the petiole, the other surface green and without stomatic bands; leaves of fertile branches 4-angled, curved and less pointed; cones small, 4-6 cm long, their scales narrow with conspicuous margins (Section *Omorica* Willkm.) 11.
2. Cone-scales oblong or rhombic, erose at apex, longitudinally undulate, thin, subcontiguous to discontiguous; foliage bright glaucous 3.
- + Cone-scales obovate or rounded, before ripening tightly contiguous; foliage dark green or slightly glaucescent 4.
3. Winter buds with appressed scales; young branches pubescent; leaves flexible, their acute tips pointing forward
- *P. Engelmanni* Engelm.
- + Winter buds with spreading reflexed-tipped scales; branchlets smooth; leaves firm and spreading *P. pungens* Engelm.
4. Cones small, 4-5.5 cm long, 2 cm thick; foliage light-colored, almost whitish *P. canadensis* B. S. P.
- + Cones larger, 5-15 cm long 5.
5. Leaves 1.9-5 cm long; young branchlets glabrous
- 5. *P. Schrenkiana* F. et M.
- + Leaves 0.7-2.5 cm long 6.
6. Leaves not more than 1.2 cm long, obtusish; branchlets pubescent 7. *P. orientalis* Link.
- + Leaves 1.2-2.5 cm long 7.
7. Cones 10-15 cm long, their scales pointed or truncate; branchlets smooth or with scattered pubescence 1. *P. excelsa* Link.
- + Cones less than 12 cm long; scales thinner and distinguished by their obliquely rounded upper margin 8.
8. Margins of cone-scales erose-dentate; pulvini pyriformly thickened in upper part; branchlets hairy 8. *P. Glehni* Fr. Schmidt.
- + Margins of cone-scales subentire; pulvini not thickened at the ends 9.
9. Young branchlets glabrous or nearly so 10.
- + Young branchlets densely pubescent 3. *P. obovata* Ldb.
10. Leaves dark green, with two white bands on the upper side
- 4. *P. koraiensis* Nakai.
- + Leaves green, without white bands; cone-scales narrower
- 2. *P. fennica* Rgl.
11. Branchlets glabrous 9. *P. jezoensis* (Sieb. et Zucc.) Carr.
- + Branchlets densely hairy 10. *P. kamtschatkensis* Lacassagne.

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Section 1. **EUPICEA** Willkm. Forst. Flora, 2 Aufl. (1887) 67-93.— Characters in the key.

1. *P. excelsa* Link in Linnaea XV (1841) 517; Shmal'g. II, 671; Asch. und Gr. Syn. Mitteleur. Fl., 1 Band, 2 Aufl., 300.— *Pinus abies* L. Sp. pl.

(1753) 1002; Ldb. Fl. Ross. III, 670.— *Abies picea* Mill. Dict. No. 3 (1759).— *Picea abies* Karsten, Deutsche Flora I (1891) 326.— *P. vulgaris* Link in Abhandl. Berl. Acad. (1827) 180.— Russian: el' evropeiskaya [European]; German: Fichte, Rottanne, Pechtanne, Fichttanne; French: épicéa commun, pesse, sapin de Norvège; English: common or Norway spruce; Ukrainian: yalina, svirka; Polish: jodla, jedlina, jegla, jeglina, sosna judla; Czech: smrk, smerek; Danish: gran, rodgran; Italian: abeto rosso, zampino; Lithuanian: egle, aglis; Finnish: kuusi, honka; Lapp: kuosa, kvosa; Zyrian: khos; Estonian: kuusk; Karelian: kuzy.

Tree 30–50 m tall, with a pointed pyramidal top; bark reddish-brown or gray, peeling off in thin flakes; young branches naked or slightly pubescent; leaves 4-angled, crowded, ascending, lustrous, dark green, 20–30 mm long and 3 mm broad, persistent for 5–7 and sometimes up to 9 years; staminate flowers between the leaves, surrounded at base with light green bracts, 20–25 mm long, purplish-red; young cones at the ends of 2-year-old shoots, elongate-cylindric, bright red, becoming green and before ripening turning brown, pendulous in maturity, 10–16 cm long and 3–4 cm thick; scales obovate; convex, the margin undulate or erose-dentate; seeds ovate, pointed, dark brown, 4 mm long, the yellowish-red wing 3 times as long as the body; shedding of seeds in early spring, the open cones retained for a long time on the tree. May, June.

- 145 Forming dense forests, often together with pine and birch; preferring loamy, rather damp soils; shade-resistant; full-grown at the age of 30–50, living up to 300 years.— European part (N. regions): the N. limit of common spruce nearly coincides with that of woody vegetation in general. Thus, on the Murman Coast it runs from Kola to the Ponoï estuary, keeping to the N. margin of the Ponoï River valley, and cutting across the E. coast of the White Sea north of the Mezen estuary. The S. limit extends from Vladimir-Volynski to Novozybkov, Starodub, Zhlobin, Karachev, Ryazan, Shatsk, and Ardatov, closely approximating the N. limit of broad-leaved forests, without penetrating into the steppe zone. **Gen. distr.:** growing in Scandinavia, in the mountains of Central Europe, as far as the Pyrenees in the W., to Tyrol and Yugoslavia (Bosnia) in the S.; it is absent in the central part of Poland and in the plains of Germany, but it grows to the N. and S. of these areas.

Note. Beyond the Volga, common spruce becomes gradually replaced by Siberian spruce, and thus the E. distribution limit is not quite clear. At any rate, common spruce still grows in the N. between the Mezen and Pechora rivers without actually reaching the latter. To the S. of the Pechora watershed, approximately as far as the 55th parallel, we encounter it in the W. foothills of the Urals in forms that differ from the type in its small cones and the scales which display various stages of transition toward the Siberian species.

Economic importance. Wood resinous, white with a reddish tint, providing building and fuel material; devoid of heartwood, yields cellulose, paper pulp, carpentry material, staves, roofing shingles, etc.; the bark yields tar and is used as a tanning agent. The seeds contain up to 30% fatty oil used for varnish production. A good pleasure-ground tree, especially when planted in groups; readily adaptable for hedges and railroad border strips.

2. *P. fennica* Rgl. Gartenfl. (1863) 95 (pro var.).— *P. excelsa* f. *fennica* Rupr. ex Beissner Nadelholzkunde 2 Aufl. (1909) 215; O. Holmberg in Hartmans Handbook I, 60; Mela—Cajander, Suomen kasvio 26.— *P. excelsa* var. *obovata* H. Hjelt Consp. Fl. Fenn. I (1888) 90.— *P. excelsa* septentrionalis Hort. et *P. excelsa borealis* Glöers et B.

Closely related to Siberian spruce; cones smaller than those of common spruce, not more than 7 cm long (rarely up to 9 or 10 cm); scales with an entire margin; seeds smaller than in *P. excelsa*; seedlings slow-growing, but very hardy.— European part: Kar.—Lap. Gen. distr.: Norway, up to 67°N. lat., Finland.

Economic importance. Recommended as a pleasure-ground tree.

3. *P. obovata* Ldb. Fl. alt. IV (1833) 201 et Icon. V (1833) tab. 499; Kiy., Fl. Zap. Sib. I, 73; Dokt. in Fedch. and Fler., Ill. opred. rast. Sib. II, 70, Figure 83; Beissner Nadelholzkunde 3 Aufl., 228.— *P. excelsa* Link var. *altaica* Tepl. Bull. Nat. Moscou II (1868) 244.— *Pinus abies* Pall. Fl. Ross. I, 1 (1788), 6 (excl. synon.) Tab. I, fg. G.—
 146 *P. obovata* Antoine Conif. 69, tab. 37, f. 2, 1847.— Russian: el' sibirskaya [Siberian]; German: sibirische Fichte, Altaifichte; French: epicéa de Sibérie; English: Siberian spruce; Tataric: kara-sheer.

Tree to 30 m tall, with a narrowly pyramidal top; bark grayish, fissured; young branchlets covered with short thick reddish hairs; leaves linear-subulate, 4-angled, spinous, 7–20 mm long; staminate aments violet-red, ovoid, 8–12 mm long and 6–7 mm thick; young cones also dark violet-red, solitary, at the ends of branches, ovoid-cylindric, 13–20 mm long and 6–7 mm thick; mature cones brown, oblong-ovoid or ovoid-cylindric, pendulous, 5–8 cm long; scales 11–15 mm long and about as broad, subreniform, broadly cuneate at base, the subentire upper margin obliquely rounded, the inner free surface beset with short hairs; ripe seeds dark brown, obliquely obovate, 4 mm long and 2.5 mm broad, the wing 10–13 mm long.

Forming riverside and mountain forests throughout the S. part of Siberia. The N. limit runs from N. Urals to Dudino village on the Yenisei, at 69°25'N. lat., through Noril'sk Mountains, and crosses the Khatanga River at 72°15', where it reaches its most northerly point, whereupon it comes down to 70°20' on the Olenek River and transects the Lena close to the 67th parallel, while on the lower Aldan it does not reach beyond 64°N. lat.; then it bends down again southward and attains the Sea of Okhotsk near Yamsk about the 59th parallel. The S. limit in the Urals is at about 55°35'N. lat. (Nadezhdino village), where it moves up toward the middle course of the Tara River at 56°30'; in the Altai area it drops again southward to 47°30'N. lat. The Siberian spruce penetrates into Dzungaria, where it grows along the tributaries of the Black Irtysh River (for example, along Koma R.), in Tannu-Tuva [Tuva Autonomous Region] and the Darhat region of Mongolia; it still occurs in Tannu-Ola Range, and along the Orkhon and Iro rivers. It is common in the Sayans, less frequent in Transbaikalia, and occurs sporadically in forests N. of the Amur; to the S. of the Amur it is displaced by the next species, although the possibility of both species growing side by side is not excluded.

Economic importance. Produces beautiful white wood.

4. *P. koraiensis* Nakai in Tokyo Bot. Mag. XXXIII, No. 395 (1919) 195.—*P. obovata* Kom. Fl. Mandsh. I (1901) 195 p. p.; Nakai Fl. Kor. II, 380.—Russian: el' koreiskaya (Korean); Japanese: Chosen-Harimomi.

Tree with soft white wood, to 20 m tall; bark reddish, dark; top ovaloid-pyramidal, dense, with slightly drooping branches; young branchlets glabrous; leaves 4-angled, 0.9—1.3 cm long, pointed, slightly curved; buds reddish-brown, ovate; cones ovaloid-oblong, 6.2—9.5 cm long and 3.0—4.0 cm thick; scales lustrous, round or obovate, the upper margin obliquely rounded. Differs from the preceding species in having glabrous young branchlets, larger cones, and pruinose leaves. (Plate VII, Figure 19).

Far East: in mountain forests along the valley of the Daubikhe R., upper reaches of Khor, Sandugan and Sanduge rivers; grows in the moister soil of valleys, rarely ascending the mountain slopes adjacent to the valleys of
147 mountain streams. Described from Korea, from Sadirien Pass in Musan Mountains region. Type in the herbarium of the Tokyo Botanical Garden.

5. *P. Schrenkiana* Fisch. et Mey. Bull. Acad. Petrop. X (1842) 253; B. Fedch., Rast. Turk. (1915) 33; Beissner Nadelholzkunde 3 Aufl. 232.—*Pinus Schrenkiana* Ant. Conif. (1847) 97.—*Abies Schrenkiana* Lindl. et Gord. in Journ. Hort. Soc. V (1850) 212.—*P. orientalis longifolia* Ldb. Fl. Ross. III (1849—51) 671.

Tree to 40 m tall, with a narrowly cylindric top; branches often pendulous; bark dark gray; young branchlets glabrous; leaves 4-angled, acute, 2—3.5 cm long (approximately twice as long as in *P. obovata*), with white waxy stomatic bands; cones large, subcylindric, 7—10 cm long and 2.5 cm thick, green when young; scales rounded at apex, entire or irregularly crenate, the margin in middle part apparently truncate; seeds and their wings brownish, the length including wing up to 16 cm. (Plate VII, Figure 18, and Plate VIII, Figure 6).

Forming compact forests on steep mountain slopes, often in groups among rocks. Centr. Asia: distributed through the mountains of Dzungarian Ala Tau and Tien Shan, from 44° to 52°E. long. from Pulkov, of particular importance for Kazakhstan. **Gen. distr.** : in the mountains of Kuldja, and further S. in the mountains of Chinese Turkestan in Tsinghai and Kansu provinces, at 1000—3500 m. Described from Kulas (Dzu. -Tarb.). Type in Leningrad.

Economic importance. Produces excellent construction wood and useful as protective planting on steep slopes against erosion by heavy rains.

6. *P. tianschanica* Rupr. Sert. tiansch. in Mem. Acad. Petrop. VII, serie XIV (1869) 72; D. Litwinow in Schedis ad Herb. Fl. Ross. VIII (1922) 25.—Exs. : HFR, No. 2446.

Tree with a conical top, closely resembling *P. Schrenkiana* Fisch. et Mey., from which it differs in its cone-scales being broader, more convex, with a slightly crenate outer margin, their lower side bright red, with longitudinal wrinkles, the upper side dark red near the margin and paler at the site of fallen winged seeds, there gray and spotted, the wing pink.

On rocky slopes, solitary or in contiguous stands, at an altitude to 1250—2750 m.—Tien Shan. Described from Mol'da-asu south of Lake Son-kul' (first report), Chatkal Range, Tere-sai R., Kara-ungur R., Irkeshtam. Type in Leningrad.

7. *P. orientalis* (L.) Link Linn. XX (1847) 294; Carr. Man. d. pl. IV, 340 et Conif. I ed. (1855) 244; ed. 2 (1867) 325; Boiss. Fl. or. V, 700; Medved., Der. i kust. Kavk. 2nd ed., 18 with plates; Litv. in Gerb. R. Flory, No. 1799; A. Grossg; Fl. Kavk. I, 27; O. Fom., Vseukr. A. N. Trudi Fiz. -Mat. vidd. XI, No. I, 14; Lipsk., Fl. Kavk. 496; Beissner Nadelholzkunde 3 Aufl. 240. — *Pinus orientalis* L. Sp. pl. ed. 2 (1763) 1421; Ldb. Fl. Ross. III, 2, 671. — *Abies orientalis* Poir. Encycl. VI (1804) 518. — *P. Wittmanniana* Carr Conif. I, ed. (1855) 260. — Russian: el' vostochnaya [eastern]; French: sapinette d'Orient; English: eastern spruce; Georgian: nadzvi, nazvi, elati; Mingrelian: nuzu; Armenian: makhri; Tataric: kyuknar; Ossetian: naz, nazi; Circassian: psei.

148 Tree to 50 m high, with a pyramidal top and dense drooping branches; bark gray, smooth, fissured; young branchlets reddish-gray or yellowish-gray, clothed with short brownish hairs; leaves obtusely 4-angled, relatively obtuse, 7–8 mm long and 1 mm broad; aments solitary, oblong-cylindric, purplish-red; young cones violet-purple; mature cones pendulous, rounded-cylindric, 5–8 cm long and 2 cm thick; scales coriaceous, brown; seeds small, dark, obovate, the wing twice the length of the body. (Plate VII, Figure 13).

Grows in the Caucasus, at altitudes from 300 to 2100 m, in pure stands or mixed with other trees (beech, pine, hornbeam), especially on shaded slopes, preferring deep protected ravines with adequate soil moisture. Living up to 300–400 years. — Caucasus: Kuban (along Belaya, Laba and Zelenchuk rivers, etc.), in Teberda, Ossetia, Svanetia, Guria, Mingrelia, Imeretia; large forests along upper course of the Kura R.; the E. limit of the distribution area runs along the Trialetskii Range and the Aragva R., the S. limit along the Chorokh R. The species is absent in Dagestan and occurs rarely in the Sukhumi area. The total extent of spruce forests in the Caucasus amounts to 500,000 hectares. **Gen. distr.:** in Turkey, near Trebizond [Trabzon], in the Anti-Taurus Mountains and in mountains of Mythia, Phrygia and Galatia.

Economic importance. The wood is white, soft, easily cleaved, light and durable, furnishes construction and carpentry material, e. g., for furniture production; the wood has good resonance. In Georgia, spruce is preferred to other conifers, as it dries easily; shavings of the resinous trunks and roots ("kveri") are used for lighting in remote localities. The bark is used for hide tanning. The bark and branches yield turpentine and a particular "eastern resin."

8. *P. Glehni* Mast. Gard. Chron. (1880) 300; Beissner Nadelholzkunde 3 Aufl. 259. — *Abies Glehni* Fr. Schmidt, Fl. Sachal., 1866, No. 417, 194 (Russian edition), Plate IV, Figures 8–13. — Russian: el' glena; Japanese: akane-zomatsu; Ainu: chikan-shunku.

Tree to 40 m high; bark gray, flaky; branchlets pendulous, pubescent; leaves 3–18 mm long, slightly curved, glaucescent, emitting a strong unpleasant odor when crushed; leaf pulvini flat in lower part, recurved above at a right angle and pyriformly thickened; cones oblong-cylindric, to 3–5.5 cm long and 2 cm thick, violet-red when young, lustrous brown in maturity; scales with denticulate-incised margin; seeds small, obovate, the wing half as long again to twice as long as the body.

In pure forest stands or together with *P. jezoensis*, in swampy places with swampy subsoil, especially near the seacoast. — Far East: grows in

- 149 Sakhalin, where it was discovered by Glehn at villages of Truotog and Chipesan in August 1861. Finds are anticipated also N. of the 50th parallel. **Gen. distr.** : in all the five provinces of Hokkaido and on southern Kurile Is. **Economic importance.** The wood is highly valued in Japan as a building material. A beautiful frost-hardy tree for pleasure-grounds.

P. canadensis (Mill.) Britt. Sterns et Poggenburg Prel. Cat. N. Y. (1888) 71; Britt. and Br. Fl. Am. 2 ed., 61.— *P. alba* Link in Linnaea XV (1841) 519.— *P. glauca* Voss ex Rehder Manual (1927) 46.— *Pinus canadensis* Ldb. Fl. Ross. III (1849) 1851, 668.— Russian: el' kanad-skaya [Canadian]; English: white or pine spruce, skunk-spruce.

Tree to 30 m high, with ascending branches; bark gray, flaky; leaves 8–18 mm long, acute, glaucescent, emitting a strong unpleasant odor when crushed; cones stalked, cylindric-oblong, 3.5–5 cm long, pale brown, shining; scales thin, semiorbicular, with even entire margins.

Grows wild in America, from Labrador to Alaska and Sitka, southward as far as New York, in the N. in some places forming the timberline and often shrubby. Wood soft, light yellow. Cultivated in Finland and recommended for extensive planting as a tree for gardens and pleasure grounds. Recommended in America as cane for grafting rare and less hardy spruce species.

P. Engelmanni Engelm. in St. Louis Transact. II (1863), 212; Beissner Nadelholzkunde 3 Aufl. 268; Rehder Manual, 47.— Russian: el' amerikan-skaya [American] or Engel'mana; German: Engelmanns Fichte; English: white spruce, Engelmann or Arizona spruce.

Tree 20–50 m high, with a dense pyramidal top, the horizontally spreading branches distinctly whorled; bark light cinnamon-colored, thin, flaky; young branchlets greenish-yellow, with scattered glandular pubescence; pulvini very prominent; leaves glaucous, 17–20 mm long and 1.5–2 mm broad, finely pointed, on fertile branches more obtuse and more curved; aments dark purple; young cones bright red; mature cones solitary, 4–6 cm long; scales obovate-rhombic, narrowed at both ends, the margin irregularly erose or denticulate; seeds small, brown, ovate, the brownish-violet wing half as long again as the body.

Growing wild in America, in the upper zone of Rocky Mountains, at elevations from 2800 to 3800 m, from British Columbia in the N. to Arizona in the S. Cultivated in gardens and parks in the surroundings of Leningrad and other towns, where it is one of the most beautiful trees. Introduced into Europe in 1863. Wood reddish, considered in its native country as one of the most valuable materials for building purposes; it is also suitable for charcoal production. The bark is a valuable tanning agent.

- 150 **P. pungens** Engelm. in Gard. Chron. XI (1879) 334; Beissner Nadelholzkunde 3 Aufl., 263.— *P. Parryana* Baron and Sarg. Silv. N. Am. XII, 47, tab. (1898) 600.— Russian: el' amerikanskaya kolyuchaya [American spiny]; German: Stechfichte, Blaufichte; English: blue spruce.

Tree to 30 m, rarely taller; branchlets yellowish-brown, glabrous; leaves very spiny, 2–3 cm long, glaucous; cones cylindric-oblong, 6–10 cm long, light brown; scales rhombic-oval, the apex narrowed and erose.— Native in America, where it grows in the Rocky Mountains, in Colorado and E. Utah, at altitudes of 2000–3000 m, along river banks and in swampy places.



Plate VII

1, 2 and 15. *Larix sibirica* Ldb.: 1) a young cone; 2) opening cone; 15) cone after shedding of seeds.— 3 and 4. *Pinus silvestris* L.: 3) a young cone; 4) cone after shedding of seeds.— 5–8. *Abies sibirica* Ldb.: 5) cone; 6) upper side of ovuliferous scale; 7) lower side of ovuliferous scale (bract visible); 8) seeds.— 9. *Pinus hamata* D. Sossn.: cone.— 10–11. *Larix dahurica* Ldb.: cones.— 12. *Picea jezoensis* Carr.: cone.— 13. *Picea orientalis* (L.) Link et Carr.: cone.— 14. *Cupressus sempervirens* L.: fruit.— 16. *Pinus pumila* Rgl.: cone.— 17. *Biota orientalis* Endl.: fruit.— 18. *Picea schrenkiana* F. et M.: cone.— 19. *Picea koraiensis* Nakai: cone.— 20–21. *Pinus pithyusa* Strangw.: cones.— 22. *Microbiota decussata* Kom.: fruit.— 23–25. *Pinus sibirica* Mayr.: 23) elongated form of cone; 24) common form; 25) mountainous form (*P. coronans* Litw.).— 26. *Pinus koraiensis* S. et Z.: cone.

Cultivated, like the preceding species, in gardens and parks; faster growing, but the regularity of its top disappears with age.

Section **OMORICA** Willkm. Forst. Flora, 2 Aufl. (1887) 67—93.— Characters in the key.

9. **P. jezoensis** (Sieb. et Succ.) Carr. Traité d. Conif. I ed. (1855) 255; Miyabe and Kudo Flora of Hokkaido (1930) 74.— *P. ajanensis* Fisch. in Carr. Traité Conif. (1855) 259; Maxim Prim. Fl. am. 261, 392; Trautv. et Mey. Fl. Ochot. No. 299, tab. 22—24; Kom. Fl. Mandsch. I, 197; Mayr Monogr. Abiet. Jap. (1890) 53.— *Abies Jezoensis* Sieb. et Zucc. Fl. jap. (1842) 110 (p. p.).— *Abies microsperma* Lindl. in Gard. Chron. (1861) 22.— Russian: el'ayanskaya [Ayan]; Japanese: Yezomattsu, kuromattsu; Ainu: shung, sungu; Orake: khaskita; Gilyak: tumsk, vissk; Goldi: khass'kta, ass'khta; German: Ajanfichte; English: yezo spruce, Ayan spruce.

Tree to 50 m tall, with a pyramidal top, though the lower part of the trunk becomes denuded of branches; branches often pendulous; petioles recurved; young branchlets yellowish, glabrous; leaves on fertile branches 4-angled, more curved; cones 4—7.5 cm long, very light brown; scales rhombic-
153 oblong, undulate, the margin erose-denticulate; seeds 2 mm long, the wing 5 mm long and 3 mm broad. (Plate VII, Figure 12, and Plate VIII, Figures 4 and 5).

Forming forests, often together with *Abies nephrolepis*.— Far East: in mountains throughout Maritime Territory from upper course of Suchan R. and the "balds" of its valley to Amur, spruce forming the first layer and fir the second. These forests stretch along the entire Sikhote-Alin Range, on steep slopes and dry plateaus with stony soils. A similar forest extends through the S. part of the Bureya Mountains; further E. and N. it is already confined to mountain slopes favoring its development, but it also penetrates to Okhotsk coast, N. of Ayan, and into Kamchatka where fragments of spruce forest are concentrated in Kamchatka River valley, especially near Shchapino village. Considerable areas of Ayan spruce have been recorded for Sakhalin. Further W., only isolated groups of spruce trees are to be found along the Zeya R. (Tukuringra Range) and in basin of Aldan. **Gen. distr.**: in mountain forests of Manchuria, E. of Sungari R., in Korea, and in N. Japan.

Economic importance. The wood provides good building and carpentry material; it is distinguished by its lightness (specific gravity of dry wood 37—39). A very beautiful tree for pleasure-grounds, its shortcoming being that growth starts very early in spring and this renders the tree susceptible to frost damage.

10. **P. kamtchatkensis** Lacasagne in Bull. de Soc. d'Hist. Nat. de Toulouse, LVIII (1929) 637.

Tree very closely resembling *P. jezoensis* Carr., but smaller, to 20 m; young branchlets densely pubescent, pale yellow, pentagonal in cross section; cones smaller and somewhat broader in relation to length than those of *P. jezoensis*; cusp of bracts much shorter than in *P. jezoensis*.

Far East: Kamch. (collected by E. K. Bezais at village of Elovka, in July 1909, and in the foothills of Mount Shiveluch, on November 19 of the same year). Grows in contiguous stands. Type in Stockholm; cotype in Leningrad.

Genus 40. **LARIX** MILLER

Mill. Gard. Dict. 7 ed. (1759).

154 Monoecious; staminate aments on leafless shoots of a year's growth or on older spurs, surrounded at base by scales; microsporophylls (stamens) terminating in a short straight mucro; cones on leafy spurs; bracts longer than the round ovulate scales, the midrib of the bract produced into a cusp; spring-flowering cones ripen and scatter their seeds in late summer of the same year and then persist on the tree for another 2 or 3 years; embryo with 6 cotyledons. Deciduous trees; leaves linear, soft, slopingly rounded on the upper side, the lower side carinate, with rows of stomata; head conical, with numerous wind-produced deflections. About 25 species in the mountain woods of the warm-temperate zone and in plains of the cool-temperate zone. Four species in the USSR.

Larix fossils are known from Tertiary formations of Kamchatka Region — *L. Preobrajenskii* Krysh., and in Quaternary formations — *Larix* cf. *sibirica* Ldb. — Omoloi R. in Arc. Sib.; *Larix* sp. in the post-Pliocene of Lad. -Ilm. (Loknya station), in Lena-Kol. (Berezovka R., Yakutia), in U. V. (Likhvin), and in V. -Kama (Galich).

1. Young shoots glabrous or with very few inconspicuous hairs 2.
- + Young shoots rather densely covered with stiff reddish hairs 4.
2. Cone-scales erose or emarginate at apex 2. *L. dahurica* Turcz.
- + Cone-scales regularly rounded at apex 3.
3. Scales of cones, especially young ones, densely velutinous 1. *L. sibirica* Ldb.
- + Scales of cones glabrous *L. decidua* Mill.
4. Scales velvety-tomentose 4. *L. olgensis* A. Henry.
- + Scales glabrous 3. *L. kamtschatica* (Rupr.) Carr.

L. decidua Mill. Gard. Dict. 8 ed. No. 1 (1768). — *L. larix* Karsten D. Flora, 1 Aufl. (1880—83) 326. — *Pinus Larix* L. Sp. pl. ed. I (1753) 1001. — *Larix europaea* Lam. und DC. Fl. Fr. III (1805) 277; Beissner Handb. Nadelholzkunde 3 Aufl. 298. — Russian: listvennitsa evropeiskaya [European]; German: Lärche; Danish: laerk; French: mélèze; Italian: larice; Ukrainian: modrina; Polish: modrzew; Czech: modrin; English: European or common larch; French: Mélèze d'Europe.

Erect tree, 25—30 m high, with a conical or irregular head; bark grayish-brown, its inner layers reddish-brown; branches drooping, ascending at the ends; young branches yellowish, smooth; leaves in fascicles of 30—40, rarely up to 60, on short spurs, unequal, very narrow, soft, 1.5—3 cm long; staminate aments ovoid to spherical, becoming cylindric, yellow; young cones purple, becoming brownish in maturity, 30—40 mm long, 20—24 mm broad; scales coriaceous, ovate-orbicular, wavy-margined; bracts short, ovate, the midrib produced into a long mucro, this exerted between the scales; seeds obovate, 3—4 mm long, with a thin ovate-semiorbicular wing to 8 mm long, ripening in October, but cones opening and scattering their seeds only in early spring; old cones sometimes giving rise to new green shoots.

Growing wild in the upper forest zone of Central European Alps, in the Carpathian Mountains, and in Czechoslovakia, at altitudes of 1000—1800 m. In the USSR only cultivated as a pleasure-ground tree, and even so infrequently.

155 **Economic importance.** Wood resinous, hard, rot-resistant. The red heartwood is particularly valued as construction material for water installations, hotbeds, etc.

 Note. The larch growing in Poland on the hills to the S. and W. of Warsaw has been separated as a distinct species, *L. polonica* Racib. Osterr. Bot. Zeit. 1912, 346, but Beissner and other German authors consider it as rather being synonymous with *L. decidua* Mill.

 1. *L. sibirica* Ldb. Fl. alt. IV (1833) 204; Kryl., Fl. Zap. Sib. I, 75; Beissner Nadelholzkunde 3 Aufl. 305.— *Pinus larix* Pall. Fl. Ross. I (1784) I (p.p.).— *P. Ledebourii* Endl. Syn. Conif. No. 131 (1847); Ldb. Fl. Ross. III, 672; Turcz. Fl. baic.-dah. II, 140.— *Abies Ledebourii* Rupr., Fl. samojed. Cisural. (1845) 269.— *L. decidua* var. *sibirica* Rgl. Gartenflora (1871) 101.— *Larix intermedia* Fisch. in litt. ex Turcz.— *L. archangelica* Laws. (1836).— Exs. HFR, No. 2575.— Russian: listvennitsa sibirskaya [Siberian]; German: sibirische Lärche; Votyak [?]: listak; Bashkirian: karagas; Tataric: karagai; Ostyak: nank; Tungus: ir'yakto, riokta; Buryat: ichegun; Nenets: kharu, kamu, khamme; Yakutian: tit.

 Erect tree, with a pyramidal head, to 40 m high; lower part of the trunk often conically thickened; young branches smooth, lustrous, pale stramineous; leaves in fascicles of 30–40, narrowly linear, 2–4 cm long and 0.1–1 mm broad, obtuse; aments ovaloid to subspherical, 5–6 mm in diameter, pale yellow; young cones reddish, light brown in maturity, ovoid, 2–4 cm long and 2–3 cm broad; scales 22–40, densely clothed on the outside with ferruginous hairs, 13–20 mm long, 10–15 mm broad, ovate, rounded ovate or orbicular, the apex rounded or truncate or emarginate; seeds obliquely obovate, 4–5 mm long and 3–4 mm broad, yellowish with dark stripes and dots; wing on one side almost straight, on the other slopingly rounded, 8–17 mm long and 4–6 mm broad. (Plate VII, Figures 1, 2, 15 and Plate VIII, Figure 9).

 Growing together with other conifers or, especially in mountains, in pure, fairly open stands. Preferring stony or sandy, generally dry soils. Nevertheless, larch forms associations not only with subshrubs and herbs but also with lichen and sphagnum undergrowth.— N. of European part: from the Onega River to the Urals which it transects at 68°N. lat., southward to Kostroma forests, further E. extending southward in a narrow tongue along the Ural Range down to the Belaya River, with a small enclave at Lake Aslikul'. In Siberia, the N. limit lies at 69°40' on the Yenisei and at 70°15' on the Pyasina River, the E. limit keeping approximately to the water divide between Lena and Yenisei, while in Transbaikalia it runs along the Yablonovyi Range. The S. limit in Centr. Asia follows the Saur and Tarbagatai ranges, from Saur Range in the direction of the Ridderskii mine. In the Altai there are 82 locations up to the altitude of 2200–2400 m. The S. limit in plains of W. Siberia runs along Tara River and close to Yaloturovsk.

156 **Gen. distr.:** In Mongolia the S. limit in the Khangai Mountains comes close to 46°N. lat., near Ulangom in the Tannu-Ola Range and pursues the Narin-gol River in the Mongolian Altai. Larch also occurs in the Chinese part of Tien Shan.

Economic importance. As regards quality of the wood, Siberian larch is not inferior to the European. The resin is valued in Siberia as chewing gum. The tree is widely cultivated in parks and gardens of the forest belt.

In Germany, the cultivated Siberian larch is sometimes designated as *L. rossica* Rgl. The tree provides timber of local importance, since the high specific weight adds to the cost of transportation. The wood sinks in water. The bark yields the so-called "sera" or "serka" for mastication. An industrial plant for the production of glue from the foliage has been set up in Novosibirsk. Extraction of Venetian turpentine has not so far been put into operation.

2. *L. dahurica* Turcz. in Bull. Soc. Nat. Moscou (1838) 101; Suk., Rast. r. Tungira (1912) 117—164; Petrov. Fl. Jacut. I, 55.—*Abies Gmelini* Rupr. Fl. Samoied. cisural. (1845) 56—56 (in nota de *Ab. Ledebourii* Rupr.).—*Pinus dahurica* Fisch. apud Turcz l. c.; Ldb. Fl. Ross. III, 673.—*Larix Gmelini* Ldb. in Gordon Pinetum (1858) 123; Litvinow in Herb. Fl. Ross. VIII (1922) 77, No. 2564.—*Pinus larix americana* Pall. Fl. Ross. II (1784) 2.—Ic.: Trautv. Plant. imag. et descr. fl. Ross. illustr. (1845) 71 et tab. 32; Beissner Nadelholzkunde 3 Aufl., 306, fig. 77; Pall., l. c., t. 1, fig. 9.—Exs.: HFR, No. 2546.—Russian: listvennitsa daurskaya [Daurian]; German: dahurische Lärche; Yakutian: tit; Tungus: ssissi; Goldi: ssesse or issi; Japanese: gui-natsu.

Tree to 30 m high, rarely a low spreading shrub with shorter leaves (9—10 mm) and smaller cones (12—15 mm long) (var. *pumila* Doct. et Fl.), or, conversely, with broad cones, larger than in the arborescent form (var. *prostrata* (Rgl.) Doct. et Fl.); root system superficial; bark reddish, thick; young branches glabrous, stramineous, becoming gray and flaky in age; leaf buds with tufts of yellowish-white hairs on the margin; leaves narrowly linear, 15—30 mm long, smooth above, with 2 longitudinal furrows beneath; cones 20—25 mm long, small, either narrowly poculiform or ovaloid and open like a flower; scales spatulate, slightly emarginate or rounded at apex, somewhat lustrous, glabrous, usually 10—16 in 3 or 4 rows or in exceptionally large cones 6—23 or even 34; bracts ovate-lanceolate, mucronate, dark-colored. Some trees have purple young cones (f. *erythrocarpa*) or green cones (f. *chlorocarpa*). (Plate VII, Figures 10—11).

Within its distribution area, *L. dahurica* forms extensive open forests, with varying undergrowth (typically *Rhododendron dahuricum* or *Ledum palustre*) and on various substrates, such as gravelly and stony soils of mountain slopes, or gleyish-podsolic soils perennially frozen to a certain depth.—E. Siberia: The W. limit runs from the Boganida and Khatanga rivers along the Lena-Yenisei watershed, then cuts across Lake Baikal and follows the E. side of the Yablonovyi Range. Far East: In Ussuri Territory, from Vladimir northward into the Okhotsk area as far as the timberline N. of Yamsk. Enclave forests occur in Sakhalin, in central part of Kamchatka, and in protected valleys of Anadyr. The N. limit runs from Kolyma estuary to the estuaries of the Khatanga and Novaya rivers at 72°30' N. lat. (the most northerly tree on earth). **Gen. distr.**: The S. limit from the Yablonovyi Range to the central part of the Great Khingan Range in Manchuria, and thence to the sources of the Sungacha River, in Korea (high-mountain zone) to 39° N. lat. Described from Transbaikalia. Type in Leningrad.

Economic importance. The economic importance of *L. dahurica* is very great, as it is the only fully arboraceous species for the whole of NE Siberia and Yakutia. It suffers greatly from fires and from fungal

diseases. Wood and resin content as in other larches. Good material for railroad sleepers and telegraph poles, piles, etc. Good firewood forest. Material for paper pulp.

Note. Various species, as yet insufficiently studied, have been described, but they are most probably mere forms of *L. dahurica* Turcz. 1) *L. Czekanowskii* Szafer (in Kosmos, XXXVIII, 1913, 1927; *L. Gmelini* × *sibirica* Szafer ibidem; Ostenfeld and S. Larsen, Monogr. 1930, 96; Sukachev in the symposium Lesnoe delo [Forestry], 1924, 39) which differs from *L. dahurica* and *L. sibirica* in the outstanding variability in shape and size of cones, either representing various combinations of characters of these two species or altogether new ones; thus, for instance, one comes across cones with reflexed bracts. This larch grows on the shores of Lake Baikal from Kultuk to Kotov and, further N. to the region of the right tributaries of the Vilyui and possibly as far as the Pyasina River, i. e., over the entire distribution area of both parental species. Practical value as in the case of Siberian larch. 2) *L. maritima* Sukatschew (in Acta silv. exper. X, 1831, Tr. po lesn. opyt. delu i lesn. prom., 1, 3–9 and 19). A big tree, 10–12 m high; young shoots reddish, with sporadically occurring short hairs or glabrous; buds dark brown, with ciliate scales; leaves to 2.5 cm long and ca. 1 mm broad; cones ovoid, 2–3 cm long and 1.7–2.3 cm broad; scales erect, rounded, faintly emarginate, completely glabrous, in 6 or 7 rows; seeds obovate, 7–9 mm long. Mountain slopes by the Botche River which flows into the sea in the Tatar Strait at about 48°N. lat. Var. *sphagnosa* occurs in the same area, but it grows in mossy bogs near the seaside, with cones 1.75 cm long. Interspersed within the distribution area of *L. dahurica* and not sufficiently differing from it to be considered a distinct species. 3) *L. Lubariskii* Sukatschew (ibid., No. 10, 10–12 and 19). Tree to 30 m, with horizontally spreading branches; young shoots glabrous; leaves 2.5–3 cm long; cones 2.2–2.5 cm long and 2.2–2.5 cm broad; mature ovulate scales grayish-brown, in about 158 6 rows; bracts blackish, visible only on the lower part of the cone. So far only a single spinney is known in the valley formed by the upper reaches of the Elldagon River, a tributary of the Suifun, on bogland covered with *Hypnum* mosses and *Osmunda cinnamomea*. It differs from *L. dahurica* merely in its larger cones. 4) *L. Cajanderi* Mayr, Fremdl. Wald- und Parkb. (1906) 297; Elwes and Henry, Trees of Gr. Brit. II (1907) 346; Kom., Vved. v. izuch. rast. Yakut. [An Introduction to and Study of the Plants of Yakutia] (1926) 117; Nedrigailov, Lesn. res. Len.-Ald. plato [Timber Resources of the Lena-Aldan Plateau] (1928) 403, 407, 411 and 413; differing from *L. dahurica* chiefly in the small cones with few scales. It comprises both dwarf depressed forms in the Verkhoyansk Range (Nedrigailov) and lofty trees (Agrafen Island on the Lena along the Kayander River, whence described by Mayr). Forms thin woods in that part of the Yakut ASSR adjoining the lower reaches of the Aldan River and the Verkhoyansk Range. If *L. dahurica* be divided into races, then *L. Cajanderi* would be regarded as the northern and continental race of *L. dahurica* Turcz.

3. *L. kamtschatica* (Rupr.). Carr. Traité des Conif. (1855) 279.—*Abies kamtschatica* Rupr., in Beitr. Pflzk. Russ. Reich. II (1845) 57; Ldb. Fl. Ross. III, 673.—*Pinus kamtschatica* Endlich. Syn. Conif. (1847) 135.—*L. kurilensis* Mayr, Mon. Abiet. Japan (1890) 66.—

L. dahurica Turcz. var. *japonica* Maxim. apud Rgl. in Gartenfl. XX, 105; Wilson Conif. and Tax. of Japan 33.— *L. dahurica* var. *kurilensis* Sarg. Silva N. Amer. XII, 4.— Ic.: Mayr., l. c., t. 5, f. 15; Rgl., l. c., t. 685; Wilson. Conif. and Tax. of Japan, t. 17 et 18.— Russian: listennitsa kamchatskaya or kuril'skaya; Ainu: kui; Japanese: gui-matsu, shikotan-matsu, karafuto-matsu.

Tree, in protected valleys to 36 m high, with a trunk diameter of 43.5 cm at the age of 250 years; head pyramidal; young shoots stramineous-gray or reddish, densely or sparsely covered with fulvous hairs, often with waxy bloom; cones small, consisting of about 15 scales; there are three forms differing in cone color, purple, green, and yellow.

Far East: Known in southern Kurile Islands, S. Sakhalin, and the Ol'ga District in Ussuri Territory. According to I. K. Shishkin, forming copses all over the E. slope of the Sikhote-Alin Range from Vladimир Bay to Valentin Bay, and only in one place spreads beyond the range over to its W. side.

Described by Ruprecht from a specimen obtained from Kamchatka but apparently derived from the Kurile Islands.

4. *L. olgensis* A. Henry in Gard. Chron. Ser. 3, LVII (1915) 109; Fitz. Partik in Sc. Proc. of the R. Dublin Soc. XIX (1929) 214.— *L. Gmelini* var. *olgensis* Ostenfeld and S. Larssen in Pflanzenareale II, 7 (1930) et in "Spec. of Gen. Larix" 51 (pro parte).— *L. sibirica* Maxim. in herb. Kom. in Acta HP XX (1901) 194 (non Ldb.).

159 A small crooked tree; young branchlets densely pubescent; cones elongated; ovulate scales evenly rounded, velutinous outside, resembling the scales of *L. sibirica*; other characters as for *L. dahurica*. According to Ostenfeld, this larch is cultivated in Denmark under the name *L. koreensis* Rafn. nom. nud. since 1902. He assumes that it grows in Korea, but the samples that I collected in Korea have completely glabrous cone-scales and do not differ from typical Daurian larch.— Far East: Uss. (seacoast in Ol'ga Bay area). Described from a specimen collected in this locality.

Genus 40a. **CEDRUS** * LINK

Link in Linnaea XV (1841) 537.

Leaves evergreen, 4-angled, densely fascicled on spurs; ovulate scales becoming woody, with thin apex; anthers with air sacs; cones maturing in the second or third year, the scales falling away together with seeds. There are 3 species.

*C. deodara*** Lawson Man. 381 ex London Arb. Brit. IV (1838) 2428, f. 2283—2286, 1838.— Russian: gimalaiskii kedr [Himalayan cedar]; German: Deodarceder, Himalayaceder; French: cedre de l'Himalaya; English: Indian cedar, deodar. Tree to 50 m tall, with pyramidal head and dark gray bark; leaves 2.5—5 cm long; cones erect, 7—10 cm long, 5—6 cm in diameter, reddish-brown; scales tomentose, tightly appressed; seeds obovate, whitish, 16—17 mm long and 6—7 mm broad, with a large light brown wing. Forming forests in the mountains of NW Himalayas, in

* Derived from the vernacular Greek name kedros, signifying generally resinous coniferous trees.

** The Hindu name deodara, deva-daru, or devdar signifies the godly tree, as it is planted around temples.

Afghanistan and Baluchistan, at altitudes of 1100 to 4000 m. Cultivated in the USSR on the S. coast of Crimea from Yalta to Alushta; also fully naturalized in Abkhazia.

Economic importance. Wood, and especially the heartwood, light brown, aromatic, hard, durable, resistant to splitting, highly valued in its native area.

Genus 41. **PINUS** (TOURN.) L.
Sp. pl. (1753) 1000 (p.p.).

160 Trees or more rarely shrubs, with flaking bark; shoots of two kinds: long shoots produced in the spring and subsequently becoming woody, and short shoots produced in the axils of dry membranaceous scalelike leaves and bearing membranaceous primary leaves and true green needlelike leaves, these in fascicles of 2—5, subtending a rudimentary terminal bud; root system strong, with deeply penetrating vertical taproots and wide-spreading lateral roots; flowers in aments replacing the short shoots at the base of the young long shoot, in the axils of scalelike bracts; stamens numerous, their connectives enlarged and scalelike at apex;* anthers opening by a longitudinal slit; anthers with air sacs, young cones borne at the ends of long shoots in the place of lateral branchlets, solitary or in groups, their stalks surrounded by scarious scales; bracts coriaceous, shorter than their ovulate scales, at length becoming rudimentary; female flowers straight or curved, mostly opening, maturing in the course of 2 or 3 years; cone-scales becoming woody, cuneate at base, the apex of the scales thickened, concave at center or umbonate, the umbo sometimes terminated by a spine; seeds rich in proteins and fatty oil, providing important food for commercially used birds and mammals. Pines are light lovers and form copses and woods on well-drained soils and on rocky slopes and bluffs. About 75 species have been described.

Fossils of the following pine species have been found: *Pinus* (*Larix*) *arctica* Schmalh. in Tertiary formations of Arc. Sib. (Novosibirskie Is.); *P. hamata* D. Sosn. in the post-Pliocene of Georgia; *P. monticola* D. Don. in the post-Pliocene of Arc. Sib. (Omoloi); *P. paleostrobus* Heer in the Oligocene of M. Dnp. (Tim) and in Sarmatian layers of L. Don (Krynka); *P. paradoxa* Palib. and *P. pithyusa* Stev. in the Pliocene of E. Georgia; *P. podosperma* Heer in Tertiary formations of Uss. (Lake Khanka); *P. praepithusa* Palib. in the Oligocene of W. Georgia; *P. sarmatica* Palib. in Sarmatian layers of Crimea (Kerch Peninsula); *P. silvestris* L. in the post-Pliocene of U. V. (Likhvin, Troitskoe, former Ostashkov County); in V. -Don (near Aleksin), near Kiev in M. Dnp., V. -Kama (Galich), and in U. Dnp. (Minsk and Smolensk regions); *Pinus* Sp. cf.; *P. Sabiniana* (?) in the Eocene of M. Dnp. (Kiev); *P. Vassoewiczii* Palib. in Sarmatian layers of Bl. (Orekhov), in Uss., Sakh., and Arc. Sib.; in Pliocene formations (?) of Balkh., Ashutas area (Chingistai), in the post-Pliocene of U. Dnp. (Timoshkovichi), in Tertiary formations of Irt. (Tomsk Region), and in Quaternary formations of Ob. Wood vestiges of *Pinites*, under various specific names, has been reported from Tertiary formations of many regions.

- 1. Scales at the base of leaf clusters or leaf pairs with decurrent base; leaves as a rule in clusters of 5; leaves 3-angled, displaying one vascular bundle in cross section (Subgenus *Haploxylon* Koehne) 2.
- + The base of the scarious scales subtending the leaf clusters or pairs not decurrent; leaves commonly 2, displaying 2 vascular bundles in cross section (Subgenus *Diploxylon* Koehne) 5.

* [The apical appendage of anthers is referred to as the scale in the Russian text.]

2. Seeds wingless, with a thick woody coat (Section *Cembra* Shaw.) . . . 3.
- + Seeds long-winged (Section *Strobi* Shaw.) *P. strobus* L.
3. Cones large; apex of cone scales narrowed and recurved 1. *P. koraiensis* Sieb. et Zucc.
- 161 + Cones medium or small; scales not elongated at apex, with a broad rounded margin 4.
4. Tree or rarely a high-mountain shrub, with firm leaves; cones rounded, with no less than 30–40 scales 2. *P. sibirica* (Rupr.) Mayr.
- + Shrub or rarely an erect tree, with thin and rather soft leaves; cones narrow, small, often with less than 20 scales 3. *P. pumila* (Pall.) Mayr.
5. Seeds large, the short weakly attached wing readily deciduous; head of tree flat-topped (Section *Pineae* Endl.) *P. pinea* L.
- + Seeds with a long firmly attached wing 6.
6. Cones dehiscent after ripening; spring shoots uninodal (Section *Laricion* Shaw.) 7.
- + Cones remaining closed for a long time; spring shoots multinodal (Section *Insignes* Shaw.) 12.
7. Leaves commonly 8–16.5 cm long; mature cones 7.5–13 cm long, yellowish-gray; apophysis glossy, inflated in upper part, with a short spine; bark dark gray 4. *P. Pallasiana* Lamb.
- + Leaves commonly 5–7 cm or exceptionally 9–10 cm long; cones 3–7 cm long; bark on the upper part of the trunk more or less red . . . 8.
8. Female flowers sessile, erect; apophysis of cone-scales nearly flat; connective of anthers pointed 5. *P. funebris* Kom.
- + Female flowers borne on recurved peduncles; epiphysis of cone-scales convex, often umbonate, sometimes terminated by a spine; connective of anther round-tipped 9.
9. Epiphysis of cone-scales with a varnishlike polished surface, with a pyramidal or rostriform umbo 10.
- + Epiphysis of cone-scales slightly glossy or dull gray, gently convex 11.
10. Ripe cones yellowish-brown; umbo of cone-scales obtuse; leaves grayish-green on both sides, acute. 7. *P. hamata* D. Sosn.
- + Ripe cones more yellow than brown; umbo of cone-scales terminated by a beaklike spine 8. *P. Kochiana* Klotzsch.
11. Cones with an oily sheen, yellowish-brown; epiphysis of upper cone-scales moderately prominent; leaves lustrous, dense; female flowers borne on very short stout peduncles 9. *P. armena* Koch.
- 162 + Cones borne on rather long peduncles, pendulous; epiphysis, except in cones fully exposed to the sun, commonly flat 6. *P. silvestris* L.
12. Epiphysis flat; leaves 11–14.5 cm long 10. *P. pithyusa* Stev.
- + Epiphysis convex 13.
13. Leaves 8.5–10 cm long; cones in 2's or 3's, rarely solitary 11. *P. eldarica* Medw.
- + Leaves 13–14.5 cm long; cones mostly solitary, rarely in pairs 12. *P. Stankewiczii* Suk.

Subgenus **HAPLOXYLON** Koehne. Deutsch. Dendr. (1893) 28.— Characters in the key.

Section 1. **CEMBRA** Shaw. The gen. *Pinus* (1914) 26.— Characters in the key.

1. *P. koraiensis* Sieb. et Zucc. Fl. Jap. 11, (1842) 28; Kom. Fl. Manch. 183; Doktor., Svod. spis. rast. Am. obl., 144; Ivashkevich, Man'chzhurskii les, 47; Ovsyannikov, Khvoinye porody [Coniferous Species], 106 and "Nashikedrovye sosny" [Our Cedar Pines], 84.— *P. mandshurica* Rupr. Mel. Biol. Ac. Petrop. (1857), 567; Maxim. Prim. 263, 393; Regel' and Maak., Rastit. Ussur. strany [Plants of the Ussuri Area] 150.— Russian: koreiskii or manchzhurskii kedr [Korean or Manchurian cedar]; Gilyak: muzir or muskr; Goldi: kol'dong; Japanese: chozen-matsu.

A tree; root system superficial; stem to 40 m or taller, 1 m in diameter; bark thick, dark gray; top dense, bluish-green, 6–8 m across, often polyconic; young shoots densely pubescent, cinnamon-colored; buds oblong-ovate, with narrow scales; leaves in clusters of 5, 3-angled, 8–12 cm long; flowering cones reddish, becoming violet; ripe cones brown, indehiscent, falling in October or November together with the seeds; cone-scales coriaceous to woody, longitudinally wrinkled, reflexed at apex; seeds smooth, obovate or obcuneate, often with a lateral wing, 14–17 mm long, 7–12 mm broad, the woody coat 1 mm thick. June. (Plate VII, Figure 26 and Plate VIII, Figure 11).

Growing on dry mountain slopes, especially with N. exposure, rarely on crests among valleys; forming forests together with firs or with the Ayan spruce, or else with maple, lime tree, or elm, constituting 10 to 90 percent of the stand.— Far East: Ze.-Bu. and Uss. (from the Bureya Mountains to the sea, south of Sovetskaya Gavan). In the N. nearly reaching the 50th parallel. Absent in wide valleys. **Gen. distr.**: Mountains of Manchuria, Korea, and centr. part of Hokkaido. Described by Siebold from Korea (cones) and by Ruprecht from the Bureya Mountains on the Amur River. Ruprecht's type in Leningrad.

Economic importance. Wood pinkish, a valuable export article as construction and carpentry timber. Seeds edible, containing cedar oil.

163 Yields turpentine and tar. Introduced into Europe as an ornamental tree in 1864. The largest tree of the Soviet Far East.

2. *P. sibirica* (Rupr.) Mayr Naturw. und forstl. Stud. im nordwestl. Russland in Allgm. Forst. und Jagdz. (1900); B. N. Gorodkov in Tr. Bot. Muz. AN, XVI (1916) 153.— *P. cembra* var. *sibirica* Rupr. Fl. Bor. ural. (1856) 43.— *P. cembra* L. subsp. *sibirica* (Rupr.) Kryl., Fl. Zap. Sib. 1, 77.— *P. cembra* Pall. Fl. Ross. tab. 2; Ldb. Fl. Ross. III, 673; L. Sp. pl. 2, p. 1000 (p. p.); F. Keppen., Geogr. raspr. khvoinykh der. v Evr. Ross. [Geographical Distribution of Coniferous Trees in European Russia] (1885) 11–38; V. F. Ovsyannikov, Khvoinye porody (1930) 99–105.— *P. sativa* cortice fissas foliis setosis subrigidis ab una vagina quinis Amman. Ruth. 178.— Exs.: HFR, No. 2548.— Sibirskii kedr [Siberian cedar].

Tree. Differing from the Swiss and Carpathian *P. cembra* L. in its strong growth, narrower top, thicker and shorter leaves, longer cones, and larger seeds. A big tree, to 35 m tall, the lower part of the stem to 1.8 m in diameter; root system with a developed taproot and strong, wide-spreading lateral roots; bark brownish-gray; top of isolated trees broad, dense, ovoid, in the case of forest trees apical, with dry brushwood underneath; branchlets clothed with long rufous hairs; leaves in clusters of 5, 6—13 cm long and 0.8—1.2 mm broad, 3-angled, slightly crenulate on the margin; resin ducts 3, internal, opposite the angles; buds not resinous, round, long-acuminate, covered with long reddish-brown scales; cones erect, indehiscent, light brown, 6—13 cm long and 5—8 cm thick; cone scales closely appressed, clothed with short stiff hairs, seeds dark brown, 10—14 mm long and 6—10 mm broad, obliquely obovate, smooth. (Plate VII, Figures 23—25).

European part: The N. limit in the Ural area lies in the Komi and Ural Mountain areas, between 64° and 57° N. lat., crossing the Yenisei near 68° N. lat. then gradually falling off southward to 60° (around Olekminsk), whereupon it passes into the E. limit, enclosing the Yablonovyi Range in Transbaikalia and N. part of Mongolia, where at the sources of the Orkhon River it reaches its southernmost point at 46°30'. The W. boundary of the distribution area again rises northward, partly coinciding with the Tannu-Ola Range and Soviet Altai, where, according to Krylov, it has been recorded in 58 locations. Widely distributed in the forest zone of W. Siberia, where B. N. Gorodkov even established a distinct bog subzone dominated by this species. The most southerly outpost in the [former] Tobol'sk Territory is situated in the vicinity of Yalutorovsk, at 56°30' N. lat., while in the Altai Mountains it is at Lake Markakul, at 48°40' N. lat.

Note. The typical form of Siberian pine is associated with plains; it grows in dense flooded forests, in bedrock sands, and on foothill slopes. Particularly handsome are solitary garden or field specimens; they also yield the greatest amount of the edible seeds. A distinctive form also grows
 164 in peat bogs of W. Siberia, *P. sibirica* f. *turfosa* Gorodk. (l. c. 166), with an erect stem 6—7 m tall, short needles, and few small abbreviated cones; the distribution area of this form adjoins the Konda, Vakh and Sosva rivers, in Tobol'sk Territory. Another form, predominant in the Altai and Sayan Mountains and in Transbaikalia and the Buryat-Mongol ASSR, was named *P. coronans* Litw. by D. I. Litvinov (Trudy Bot. Muz. AN, XVI, 166. 1916), but is more correctly designated by Krylov (l. c. 79) as f. *coronans* (Litw.) Kryl. (Plate VII, p. 25); a tree to 20 m tall, with a broad dense and often dome-shaped top that starts very low, and leaves shorter than in the type; cones small and relatively broad, not more than 6—7 cm long and nearly as broad. Finally, a form occurring on stony mountain soil, f. *depressa*, is semidecumbent, commonly infertile; it grows above the timberline (2100 m above sea level) in the Altai and Sayans and in N. Mongolia. Cultivated as a tree for pleasure grounds since the 18th century.

Economic importance. Wood firm, light, with a pleasant scent, provides excellent carpentry material. The "nuts" form an article of a special trade; they are a favorite delicacy in many places and they yield oil and a kind of milk. The endosperm of the "nuts" contains up to 50% of oil.

3. *P. pumila* (Pall.) Rgl. Ind. sem. Hort. Petrop. (1858) 23; Beissner Nadelholzkunde — 3 ed., 337; H. Uyeki Corean Timber trees 36; Kom., Fl. Manchzh. I, 189; Fl. Kamchatki I, 102; V. F. Ovasyannikov, Khvoinye porody 111; O. A. Kuzeneva, Tr. Bot. Muz. AN, XVIII (1920) 39. — *P. cembra pumila* Pall. Fl. Ross. I (1784) 5; Maxim. Prim. 262 et 392; Fr. Schmidt. Fl. Amgun. No. 351; Fl. Sachal. 420; Rgl et Til. Fl. Ajan. 120. — *P. pygmaea* Fisch. in schedulis Herb. — Ic.: Pall., l. c., t. 2; H. Uyeki, l. c., tab. 7 et 8. — Exs. HFR, No. 2550.

A shrub, with several branches from base, these prostrate and then ascending; in the forest zone an erect tree to 5 m tall; in the mountains denser and more depressed, and on heights exposed to strong winds trailing on the ground; young shoots densely clothed with short yellowish-brown hairs; winter buds reddish, cylindric, acute, abundantly resinous; needles in cluster of 5, 4–7 cm (rarely up to 10 cm) long, 3-angled, minutely crenulate on the margin; resin ducts 2, close to the dorsal epidermis [marginal]; cones in groups, short-peduncled, 3.5–4.5 cm long and 2.5 cm thick, in the fall of the first year violet-purple, becoming green the following spring and light brown toward maturity in October of the following year, indehiscent but contractile after falling and thus releasing the seeds. June. (Plate VII, Figure 16).

165 E. Siberia and Far East: growing in the Sikhote-Alin and Tukuringra mountains, on Sakhalin, in Stanovoi Range, and in mountains between the Aldan and Olekma rivers, at Lake Baikal and on the Vilyui R. The extreme point in the W. is located in the Tunka "balds." Common in the Okhotsk area and Kamchatka. In the N. it occurs in the Verkhoyansk Range, on Okotsk coast and further N. to the divide between the Anadyr River and rivers flowing into the Arctic Ocean. **Gen. distr.**: outside the Soviet Union, the species occurs in the Great and Lesser Khingans, in high mountains of Korea and in the mountains of Hokkaido where the southernmost point of the distribution area is situated to the S. of the 36th parallel, in the Kurile Islands. Described from E. Siberia. Type in Leningrad.

Economic importance. The economic importance of *P. pumila* is due to its dense thickets which provide protection for animals of commercial value such as squirrel and sable. The nuts are suitable for production of nut milk and oil. Dry distillation of the branches yields terpenes, etc. Introduced into England in 1817.

Section 2. **STROBI** Shaw., l. c., 30. — Character in the key.

P. strobus L. Sp. pl. II (1753) 1001; Beissner Nadelholzkunde 3 Aufl. 346; Shaw. Genus Pinus 36; Syreishchikov, Mosk. Fl. I, 62. — *P. nivea* Booth ex Carr. Trait. Conif. 305. — *P. alba canadensis* Provancher Fl. Canad. II, 554. — Sosna Veimutova or belaya [Weymouth or white pine]; English: white pine, pumpkin pine, sapling pine, Weymouth pine; German: Weymouthkiefer, Strobe.

Tree to 50 m; bark greenish-gray, remaining smooth for a long time, at length becoming flaky; top rather slim, dense; leaves in clusters of 5, slender, flexible, 6–10 cm long, sharply 3-angled, the outer side light green, the inner glaucous; cones pendulous, in groups of 1–3, long-cylindric, slender, at first green, at length brown; scales with a yellowish-gray little-thickened epiphysis and obtuse apex; seeds ovate, brown, 5–6 mm long, the broad wing 18–20 mm long.

N. Am. From Newfoundland to Manitoba in Canada, in Adirondack and Allegheny Mountains, forming large forests. Described from Virginia and from Canada. Type in London. In the USSR only cultivated in farmstead gardens and parks; growing satisfactorily (Moscow area, U. V., Novgorod, Leningrad and Vitim areas, etc.). Good construction timber. Recommended for extensive commercial planting. Preferring deep loams.

Subgenus **DIPLOXYLON** Koehne, l. c. 30. — Characters in the key.

Section 1. **PINEA** Endl. Syn. (1847) 182 (p.p.). — Characters in the key.

P. pinea L. Sp. pl. II (1753) 1000; Beissner. Nadelholzk. 3 Aufl. 379; Medv., Der. i kust. Kavkaza, 2nd ed., with tables; Shaw. Genus Pinus 48 c. ic. — *P. sativa* Lam. Fl. Fr. II (1778) 200. — *P. maderiensis* Tenore in Ann. Sc. Nat. ser. A, II (1845) 379.

Tree to 15–25 m tall, with flattened widespreading top; bark grayish-brown, fissured, falling off in slices; wood white; leaves 13–20 cm long, 166 firm, the margins very scabrous, the back rounded; inflorescence dense, thick, oblong; scales round, their margin crenulate-ciliate; cones maturing in the third year after flowering, solitary or paired, borne on rather long thickened peduncles; ripe cones erect, subsessile, ovoid-globose, large, 11–13 cm long, often with large incrustations of white resin; scales thick, glossy; epiphysis quadrangular, flat; seeds large, oblong-obovate, with a thick brownish-red coat, 18–20 mm long, the wing rudimentary or wanting. Growing wild at the S. extremity of the USSR, in the Chorokh River valley (Turkey) south Batumi; occurring in cultivation in Mingrelia, and on the S. coast of Crimea. Described from Italy. Type in London.

Economic importance. Wood only slightly resinous, light and durable, valued for construction timber (among other uses, employed in the construction of ocean-going ships and for masts) and carpentry material. Yields turpentine. Seeds large, rich in protein and fat; eaten fresh, roasted or salted; yielding oil and used in popular medicine as pectoral demulcent.

Section 2. **LARICIONES** Shaw., l. c., 25. — Characters in the key.

4. **P. Pallasiana** Lamb. Pin. 2 ed. II (1828). — *P. laricio* var. *Pallasiana* Antione Conf. (1840) 6; Asch. und Gr. Syn. 1, 2 Aufl. 333; E. V. Vul'f, Fl. Kryma 1, 34. — *P. laricio* M. B. III (1819) 623; Shmal'g. II, 670. — *P. maritima* Pall. Ind. taur. (1795) 59. — *P. nigra* var. *caramanica* Rehder. Man. Cultiv. trees N. Amer. (1927) 61. — *P. taurica* Hort. — *P. tatarica* Hort. — *P. pinaster* Stev. Verz. Taur. wildw. Pfl. (1857) II. — *P. nigra* Antoine var. *Pallasiana* Antoine ex Bernhard in D. Dendrol. Ges. (1931) 39. — Ic.: Lamb., l. c., t. 5. Russian: sosna Pallasova or krymskaya [Crimean]; Tataric: Karachami, cham, or tsham.

Tree to 45 m, with pyramidal top; branches with upturned tips; bark dark brown, fissured, reddish at the top of the stem, on young branchlets reddish-yellow; leaves 8–13 cm long, stiff, green; connectives of anthers

round-tipped, pectinate-denticulate; cones sessile, horizontal, ovoid-conical, 5–10 cm long and 4.5–6 cm thick; epiphysis rhombic, with oval umbo; conelets glaucous-violet, becoming brownish yellow in maturity; seeds 5–7 mm long, gray with dark spots, the brown wing 5–6 mm broad.

Forming forests in the mountainous part of Crimea, from Bakhchisarai and Inkerman to Sudak and Echki-dag Rocks in Oruz River valley. The Crimean pine covered in antiquity nearly all the mountain slopes and spurs right down to the coast (Kondarski, 1883), but now it persists only in more secluded places and it is known in the Caucasus only from the mountain slopes near the village of Volanka south of Gelendzhik.

167 **Economic importance.** Timber used for ship-building and construction work in general. The tree yields turpentine and camphor. Lives 500–600 years. Prefers calcareous soils, but grows also in gravelly and sandy soils.

Note. Related to Austrian pine and belonging to the general cycle of *P. nigra* Arnold that grows in the mountains of Centr. Europe, all over the Mediterranean region, and in Asia Minor.

5. *P. funebris* Kom. Fl. Mansh. I (1901) 177; Beissner Nadelholzk. 2 Aufl. 436; Nakai. Fl. Koreana II (1911) 379.

Tree 6–12 m tall; bark gray, reddish on the branches; top spreading and bushy; young branchlets smooth, yellowish or reddish; leaves 5–10 cm long, straight, firm, scabrous on the margins, rounded on the back, dark green; staminate aments dense, spikelike, with short scalelike stamens; apical appendages of connectives membranous, keeled, pointed; female aments solitary or paired at the ends of young shoots, red, with mucronate scales; cones ca. 5 cm long, gray; cone-scales with a rhombic nearly flat epiphysis; seeds with a large wing, this half as long again as the body.

Growing in the Far East on mountain slopes in gravelly soil, forming small woods, mostly in places exposed to the sun, also on sandy offshore levees at Lake Khanka (N. shore), and on rocky scarps. South Ussuri Territory along the Lefu River, just above Nikolaevka, along the Sandugan River and Suputinke River (Sosnovaya Pad), Lynchekheza and Maikhe rivers and in the Pos'et area, where it often occurs on seashore scarps. Described from Korea. Type in Leningrad.

Note. Very similar to the red Japanese "akamatsu" or "me-matsu" pine, and therefore H. Uyeki (Korean timber trees, 47) reports the latter for the whole of Korea right through to the USSR frontier (except for mountain peaks and two small areas along the Yalu River). Our species differs from the Japanese pine in having short cuds, short leaves, short-pointed anther-bearing scales and longer conelet bracts. The attempts of other authors to identify *P. funebris* with *P. silvestris* (Masters) or with *P. sinensis* (Shaw) are unfounded, as it undoubtedly represents a northern geographical race derived from *P. densiflora* S. et Z. which is distributed in Japan and Korea.

Economic importance. Produces firm resinous wood. Very suitable for consolidation of mountain slopes. Recommended for planting, particularly in view of the fact that other trees of the Far East grow poorly on gravelly insolated slopes.

6. *P. silvestris* L. Sp. pl. (1753) 1000; Beissner. Nadelholzk. 3 Aufl. 412, fig. 104, 105; Pall. Fl. Ross. I, 1, Tab. II, fig. I, i; Ldb. Fl. Ross. III, 674; Kryl., Fl. Zap. Sib., I, 80; Shmal'g., II, 670; O. Fom., Golonasinn'ovi

Kavkazu ta Krimu 21.— *P. rubra* Mill. Dict. No.3 (1759).— *P. rigensis* 168 Desf. Cat. Hort. Paris. Arb. II, 61.— Ic.: Pall. Fl. Ross. t. II, f. 1, i — Russian: sosna lesnaya or obyknovennaya [forest or common pine]; English: Scotch pine, wild pine; French: pin silvestre; German: gemeine Kiefer, Föhre, Kien; Georgian: pitchvi; Ossetian: pichi; Kabardian: uazdigei; Polish: sosna pospolita; Finnish: menti; Latvian: prede; Tataric: narat; Buryat: narchun, narassun; Kirghiz: karagai; Yakutian: bes; Bashkirian: karagai or kharagai.

Tree, with an erect trunk, 20–40 m tall; top round; bark light reddish-brown, fissured, on branchlets yellowish, scaly; leaves 5–7 cm long, glaucescent; male flowers gathered in an ovaloid-conical or oblong cluster, the scales entire; cones solitary or in 2's or 3's, borne on recurved peduncles, maturing in the second year; mature cones gray, dull, ovaloid-conical; epiphysis subrhombic, 4–6-edged, the edges connivent toward the recurved umbo; seeds small, rounded-oblong, blackish or gray, the wing 3 times the length of the body. June. (Plate VII, Figures 3–4 and Plate VIII, Figure 8).

Throughout its distribution area, common pine forms compact woods ["bory" in Russian], chiefly on sandy soils. Together with spruce, etc. it also occurs on podsolic soils in mixed or coniferous woods almost everywhere. In the steppe region it is confined to riverside sands and chalk; it does not ascend onto the water divides. In the North, it favors particularly wind-blown glacial sands and slopes of land elevations. In Siberian mountains it prefers dry sunny slopes with gravelly soil. It also occurs under other conditions, but then it is in a more or less depressed state. It lives up to 400 years. USSR: The N. limit runs in the Murman area from the N. extremity of Lake Enare to White Sea "neck", well to the S. of the Ponoï estuary, then from the S. shore of Mezen Bay to beginning of the Pechora River delta, on the Usa River and through the Arctic Urals to the beginning of the estuarine portion of the Ob River; at the mouth of the Yenisei it rises to 69°N. lat., and in the upper reaches of the Pyasina River it reaches beyond the 70th parallel and keeps to this most northerly latitude as far as the Olenek River, and to the E. of it it descends near the town of Zhigansk on the Lena River toward the Arctic Circle, whereupon it comes down still further S., passing along the N. margin of the Aldan River valley, while in the direction of the Sea of Okhotsk it even juts out to the S. of the 60th parallel near Yamsk. Common pine is absent altogether from Kamchatka. The S. limit in the USSR cuts across the W. boundary of the Union somewhat to the N. of Kamenets-Podol'sk, then across the Bug River in its middle course, the Dnieper slightly to the S. of Dnepropetrovsk, and the Donets at the beginning of its lower course, whereupon it rises steeply to the N. and cuts across the Don some distance S. of Voronezh and across the Volga near Saratov. To the E. of the Volga valley the S. distribution limit runs from Samara to Orenburg [Chkalov] and the upper reaches of the Tobol River; it then cuts across the Baraba Steppe. The pine occurs commonly in the piedmontane strip of the SE Urals and the Altai where it penetrates southward to Riddersk and even to Bukhtarma. In the Altai, however, pine does not penetrate deep into the mountains, but keeps to its W. and N. edges; it does not generally rise above 800 m, rarely 169 up to 1000 m. Further to the E. it includes the N. borderland of Tannu-Tuva and the Mongolian People's Republic, the Sayan mountains and Transbaikalia. On the Amur River the pine occurs commonly as far as the Zeya R., further

it is to be found in small numbers on the Tom River (Bochkarevo), Arkhare, and in the Bureya Mountains, and, finally, it is reported for the Amgon River, where it reaches the extreme point of its distribution in SE direction. Outside the contiguous distribution area, common pine grows in the Caucasus, from the Kuban River to Dagestan and from Abkhazia, through Svanetia and Rach area to Manglisi. In Crimea it grows in mountain gorges, e.g., in Nikitskaya "yaila".* **Gen. distr.** : Outside the USSR, common pine grows in Scandinavia, throughout Centr. Europe, in the mountains of Spain, N. Italy, and the Balkan Peninsula. Described from Scandinavia. Type in London.

Note. Distinct forms: 1) var. *erythranthera* Sanio (Index Sem. H. Berol. (1871) app. 8), with carmine red male flowers; occurring rarely in the NW of the European USSR, e.g., near Leningrad on dunes around Sestroretsk; 2) var. *lapponica* Fries (1888) (= *P. lapponica* Mayr Fremdl. Wald- und Parkb. (1906) 348), with broader and shorter leaves remaining green for 4—7 years, the resin ducts numerous; cones yellowish; growing in Karelia, on Murman Coast, and Finland; 3) var. *sibirica* Ldb. (Fl. Alt. IV (1833) 199) — cones with a broader base and more numerous scales; epiphysis more prominent, subpyramidal, especially on the outer more illuminated side of the cone; Altai mountains; 4) var. *nana* Pall. (Fl. Ross. I (1784) 6; Schedae ad HFR, No. 1597) — trunk 2—3 m tall; erect or in lower part creeping, hidden beneath mosses; leaves small, short, crowded at the ends of branchlets; resin ducts in leaf cross section 10—13; aments and cones very small; anthers yellow or red; growing profusely in peat bogs throughout the N. and to some extent the Centr. sections of the European part and the W. and N. parts of Siberia; base of stem passing into the root, often hooklike; fruiting profusely; differentiated into a number of forms according to moisture content of the bod and the growth of the peat mosses: *P. silvestris* v. *sphagnicola* Rupr. (Symbolae (1846) 224). — *P. s. brevifolia* Rogov. (Obozr. rast. Kievsk. uch. okr.) 290 (1868). — *P. s. f. f. sphagnicola* Willkommi and Litwinowi Sukachev. (Lesnoi Zhurnal, No. 3 (1905) 366—371); 5) var. *echinata* Link. in Linnaea XV (1841) 490; Litvinov, Schedae ad HFR, No. 1598. Var. *sibirica* Ldb. Fl. alt. IV, 199; epiphysis prominent, pyramidal, often pointed; Transbaikalia and Amur; according to Litvinov, connected by transitional forms with common pine; 6) var. *cretacea* Kalenicz. (Bull. Soc. nat. Mosc. 1849, I, 301. = *Pinus cretacea* Kalenicz., ibid. 295); a calcicolous pine, with a low, bushy but thin top, and short firm needles, growing on chalks of Kursk District and generally on chalk outcrops.

Economic importance. Pine forests yield excellent construction and carpentry timber, fuel, tar, resin, pitch, black or marine tar, carbon black, turpentine, essential turpentine oil, and colophony. The foliae yields
170 so-called pine-wool and bedding litter; young shoots (*turiones pini*) have medicinal use; the pollen is used in pharmacies as a substitute for lycopodium. The sweet juicy sapwood is eaten in some localities in Siberia either in fresh condition or ground or else it is used for food in mixture with flour. Pine plantings are used for sand fixing. An excellent ornamental tree for places with sandy soil.

7. **P. hamata** D. Sosn., Fl. Tiflisa (1925) 11; A. Fom. in Moniteur du Jard. Bot. de Tiflis 34, p. 15—27; A. Grossheim, Fl. Kavkaza I (1928)

* [Monoclinial limestone plateau dissected by karst valleys.]

1, 26. — *P. silvestris* var. *hamata* Stev. in Bull. Soc. Nat. Moscou No.1 (1838) 51 and No.2 (1857) 387. — *P. silvestris* E. Vul'f, Fl. Kryma I, 37. — Russian: sosna kryuchkovataya [hooked pine]; Tataric: cham or tsham, narat; Georgian: pitchvi; Svanetian: gogib; Armenian: tegosh, pichi, shami; Circassian: uadzigei, nuostoga; Abkhazian: amsa, apsa; Lezghian: achit; Kumyk: karagai; Avar: naekh; Greek: pitiya.

Tree; the erect trunk to 36 m tall, often irregularly thickened in lower part; top pyramidal or round; bark on the lower part of the trunk dark brown, deeply fissured, on upper part reddish-yellow, scaly, on branches gray, on young branchlets pale yellow; leaves stiff, straight or slightly curved, mucronate, glaucescent, 2–7 cm long and 1–2 mm broad; male cones dense, ovoid-conical, the scales slightly denticulate on the margin; ovulate cones solitary or in 2's–4's, at first green, turning reddish-brown, at length brownish-gray, ovaloid-spherical, recurved, lustrous, 1.5–5.5 cm long and 2–4 cm broad at base; epiphysis subrhombic, rugose, flat or pyramidal, the umbo of scales on the illuminated side of the cone produced into a hooked spine; seeds 4–5 mm long, the wing 13–15 mm long and 4–5 mm broad. (Plate VII, Figure 9).

Forming woods and even forests on mountain slopes and dry uplands. — European part: in Crimea this pine grows only on high monoclinal limestone plateaus (yailas), from Alachuk natural landmark area above Kokkozy, to Gurzufskoe Sedlo [saddle]. In the Caucasus it grows nearly throughout the Greater Caucasus, from the Black Sea eastward to the Kakhetian Range and Zakataly District, on Adzhar-Imeretian Range, on Trialetskii Range, at Borzhomi and further east to sources of the Kyuruk-chai River; from Elisavetpol' it passes into Turkey toward Trebizond [Trabzon] and central Anatolia.

Economic importance. Yields construction timber, fuel, and turpentine that is distinguished by the property of turning the plane of polarized light to the left [levorotatory]. The extraction of turpentine from the soft resin amounts in Crimea to 12.6–13.3 percent.

8. *P. Kochiana* Klotzsch. in Linnaea XXII (1848) 296; C. Koch. Dendrologie II, 2 (1873) 280. — *P. montana* in Medv., Der. i kust. Kavk., 2nd ed., 9, with plate.

Tree or shrub, with an erect or curved trunk, often 3–5 m tall; top dense, with ascending branches; bark gray and fissured below, reddish-yellow above; leaves firm, thickish, 3.5–5 cm long, green, minutely serrulate on the margin (magnifier), often prolonged into a needle-shaped point; male inflorescence oblong-cylindric, dense, the scales dentate-pectinate; cones solitary or in pairs, rarely in 3's or 4's, ovaloid-spherical and erect when young, in maturity sessile, ovoid, brown, violet-brown or light gray, 2–5.2 cm long; epiphysis flat or pyramidally inflated, often with a sharp elongate and curved umbo; seeds small, ovate or ovate-oblong, the whitish-gray wing 2–3 times the length of the body.

Caucasus: mountain woods of SW Transcaucasia, chiefly in localities approaching Turkey along the Chorokh River, at Artvin, etc. Recorded near Bakuriani in mountains of Shuglian-ubani, at Lake Gök Gölü and at Ardahan. **Gen. distr.** : Turkey.

Economic importance: The wood provides excellent material for lathework.

9. **P. armena** Koch in Linnaea XXII (1849) 297; Id. Dendrol. II, 2, 281; Fom. in Monit. Jard. bot. Tiflis XXIV, 20—22; Vseukr. A. N. Trudy Fiz.-Mat. Vidd. XI, No. I, 26.— *P. montana* var. *caucasica* Medw., Der. i kust. Kavkaza, 2nd ed., No. I (1905) 11.— *P. caucasica* N. Busch, Tsennye.derev'ya Kavkaza 5 (KEPS) N. 16.

Tree of medium size, 7—9 m tall, or shrub, with spreading often crooked branches; bark rusty or golden-gray; leaves 2.5—3.8 cm long, mucronate; male aments hemispherical; appendage of stamens broadly ovate or semideltoide; mature cones ovoid, borne on very short peduncles, erect or horizontally spreading, 4—5.5 cm long, dark yellow; epiphysis of upper cone scales raised, that of lower scales flat; seeds obovate, with a marbled black pattern, the wing 3 times the length of the body.

Caucasus: Growing in mountainous or even subalpine parts of SW Transcaucasia, e. g., Adzhar-Imeretian Range, mountains of Tsikhis-dzhvari. **Gen. distr.** : Turkey, from Ardahan and Karo and in districts of Oltu and Artvin.

Economic importance. Wood fine-grained, with heartwood of brownish-red color, provides material for turning.

Section 4. **INSIGNES** Shaw., l. c. — Characters in the key.

10. **P. pithyusa** Strangw. Gard. Mag. XVI (1840) 638; Steven in Bull. Soc. Nat. Mosc. XI (1838) 48; Medv., Der. i kust. kavk., 2nd ed., with 14 plates. A. Grossh., Fl. Kavk. I, 16.— *P. halepensis* *pithyusa* Stev., ex Gord. Pin. (1858) 166; Beissner Nadelholzkunde 3 Aufl. 392.— *P. abchasica* Fisch. ex Gord. Pin. (1858) 166.— *P. halepensis* Shaw Genus Pinus 78 (p. p.).—

Tree; trunk 18—24 m tall, erect, with brownish-gray, fissured bark; branches brownish-red or brownish-yellow; top spreading, rather thin; leaves ca. 12 cm long, slender, dark green, scabrous-margined, acute; male inflorescences in capitate clusters, their scales rounded, sinuate-toothed, reddish-yellow, with a green spot at center; cones solitary or in 2's or 3's, rarely in 4's; mature cones short-peduncled or sessile, horizontally spreading, ovoid-conical, to 10 cm long, brownish-red; scales with a glossy smooth flat apophysis; seeds blackish, the brown obtusish wing 3—4 times the length of the body. (Plate VII, Figures 20—21).

Growing along the Black Sea coast of the Caucasus, on rocky and sandy seaside slopes, up to 300 m above sea level, from Varvarovka village near Anapa and as far south as Cape Pitsunda, where it forms an extensive grove right down by the seashore.

Economic importance. The wood is used for planking of ships and for miscellaneous carpentry work; yields large quantities of resin and turpentine. Cultivated as an ornamental tree.

11. **P. eldarica** Medw. Acta H. Rifl. VI, II (1903) 21 cum ic.; id. Mitt. d. d. dendrol. Gesell. (1903) 56; Medv., Der. i kust. Kavk., 2nd ed., No. I (1905); M. Savich., Kavkazskoe khozyaistvo, Nos. 19—20 (1911).— *P. halepensis* var. *eldarica* Beissner Nadelholz. (1930) 3 Aufl. 392.

Tree; trunk straight or crooked, 12—15 m tall; bark brownish-gray or light gray, not flaking; head broad-topped; leaves stiff, green, 6—9 cm

long; scales of male flowers rounded, denticulate-margined; cones pedunculate, solitary or in pairs, rarely in 3's or 4's, ovoid-conical, on the average ca. 6 cm long, light reddish-brown; scales irregularly rhombic, glossy, smooth, the whitish-gray apophysis concave; seeds blackish, 6—7 mm long, the reddish-brown wing 18—28 mm long. (in her)

Caucasus: forming groves, occupying an area of about 50 hectares in crevices of clayey sandstone on the N. slopes of Mt. Eilyar-bugi, at altitudes of 450—600 m, near the right bank of the Iora (left tributary of the Kura) in Georgia.

Note. Closely resembling the Aleppo pine, *P. halepensis* Mill, which is widely distributed through the Mediterranean region from Algeria to Asia Minor, but differs from that species in its semi-erect cones and the flat apophysis of the ovulate scales; cones fewer in each whorl; leaves shorter.

Economic importance. Could be used for afforestation of dry mountain slopes, as it is very drought-resistant; seeds germinate outstandingly well. Yields resin.

12. *P. Stankeviczi* (Suk.) Fom. in Monit. du Jard. Bot. de Tifl., XXXIV, (1914) 21.—*P. pithyusa* Stev. var. *Stankewiczii* Suk. in V. Sukachev, O novoi dlya Kryma sosne in Trav. Soc. Nat. St.-Petersb., XXXV, 3 (1906) 37; E. Vul'f, Fl. Kryma, I (1927) 39.—*P. bratia* Gen. ex Bernhard in Berichte d. D. Dendrol. Gesell. (1931) 50.— Ic.: E. Wulff in Vegetationsbilder von Karsten und Schenk XVII, I. Taf. 3a.

Tree; trunk straight, 8—9 m tall; head spreading, round; old bark yellowish-brown or grayish-brown; young bark light gray; leaves 13—17 cm long, dark green; cones solitary, rarely paired, obliquely ascending, 6—8.5 cm long, ovaloid-conical, yellowish-brown; scales with inflated apophysis and a small umbo; seeds ovate, dark gray, 7 mm long, the wing 25—27 mm long.

European part: Growing in Crimea in Sudarskaya woodland, on scarps of slope facing the sea, in dry marlaceous soil, together with juniper and oak. Closely related to the Caucasian *P. pithyusa*. Endemic. Type in Leningrad.

Family **TAXODIACEAE*** F. W. NEGER **SEQUOIA** ENDL.

The genus *Sequoia* is most widely distributed among coniferous fossils of the Tertiary period. The following species have so far been reported from Tertiary formations of the USSR: *S. carbonaria* (Rogowicz.) Schmalh.—from the Eocene of M. Dnp. (Kiev); *S. Couttsiae* Hr.—from the Eocene or lower Oligocene of M. Dnp. (Mogil'no, Volyanshchina, Molotychi); var. *robusta* Schmalh.—from the same formations of M. Dnp. (Mogil'no, Volyanshchina, Ekaterinopol'e); *S. disticha* Hr.—from Tertiary formations of Kamch.; *S. Langsdorffii* (Brong.) Hr.—from Tertiary formations of Transcaucasia, M. Dnp. (Tim), L. Don (Krynka), Ob (Lozva), Ar.-Casp., Arc. Sib. (Novosibirskie Islands), Uss. and Sakh., Balkh. (Ashutas); *S. Reichenbachii* Hr.—in the Eocene of M. Dnp. (Lavy, Kursk area), this location not being fully verified; *S. sibirica* Hr.—in Tertiary formations of Lena-Kol. (Chirymyi-kaya); *S. cf. resimblii* S. spinosa Newb.—in Kamch. (Komandorskie Islands); *S. Sternbergii* (Goepf.) Hr.—in Tertiary formations of M. Dnp. (Volyanshchina); Ob (Lozva), Balkh. (Ashutas), and Uss., the report referring to the Sakhalin region being doubtful.

* Only fossilized.

Genus **TAXODIUM** RICHARD.

The genus was widely distributed in the Tertiary period in the Eocene in the Asian part of the USSR and in the Miocene in the European part. Species recorded: *Taxodium distichum miocenum* Heer — in Sarmatian formations of L. Don (Krynka), in Tertiary formations, mostly Paleocene, of Ob (Tomsk), Arc. Sib. (Novosibirskie Islands), Lena-Kol. (Chirymyi-kaya), An., Uss. (many locations), Sakh. (many locations), and Ar.-Casp. (Yar-kue); *T. gracile* Heer — in Lena-Kol. (Chirymyi-kaya) and Uss. (Rechnoi Peninsula); *T. tinajorum* Heer — in Lena-Kol. (Chirymyi-kaya) and possibly in Uss. (Pos'et); *Taxodium dubium* Heer — in Tertiary formation of Ar.-Casp. (Dzar-kue); *Taxodium* sp. — from Kamch. and Balkh. (Ashutas).

Genus **GLYPTOSTROBUS** ENDL.

In the USSR only in fossil state: *G. europaeus* Heer and, probably identical with it, *G. Ungeri* Heer were widely distributed through the USSR, in Asia still at the end of the Cretaceous period, occurring in Arc. Sib. (Novosibirskie Islands), An. and Uss. (Pos'et, Novokievskoe, Amagu, Sikhote-Alin). Also reported from the Eocene of M. Dnp. (Kiev), and from Tertiary formations of Balkh. (Ashutas) and Kamch. (Ashutas).

Family XIII. **CUPRESSACEAE** F. W. NEGER

174 Flowers at the ends of short branchlets or axillary; male cones with broad laterally or scutiformly attached scales and 3—5 free sporangia (anthers); sporophylls of ovulate cones with 1 to numerous erect ovules, rarely none and then ovules borne at the end of the branchlet; cones woody, dehiscent or baccate; seeds wingless or narrowly winged; cotyledons 2, rarely 5 or 6; leaves decussate or in whorls of 3; heterophyly frequent, some of the leaves on shaded branchlets and in seedlings needle-shaped, others on sun-exposed branchlets scalelike and imbricated.

Apart from reports presented here in connection with each genus, authenticated reports of fossilized wood from the Tertiary period refer to the genus *Cupressinoxylon*. It is not possible to establish a closer relationship between this genus and any one of the contemporary genera.

Subfamily **Juniperoideae** PILGER

Pilger in Engl. u. Prantl. Pflanzenfam. I, IV (1926) 396.

Mature cones fleshy, the scales united into a fleshy strobile. Two genera, of these one in the USSR.

Genus 42. **JUNIPERUS** * L.

Gen. pl. (1737) 311.

Shrubs or small trees, adapted to dry climate and poor soils; roots with internal mycorrhiza; flowers diclinous, dioecious or monoecious, the distinction being without value as specific character because of the

* Derived, according to Ascherson, from the Latin name *Juniperus*, mentioned in the writings of Virgil.

In the view of others, from the Celtic word *jenepirus*, spiny, referring to the spiny leaves of some species.



Plate VIII

- 1 and 2. *Abies sibirica* Fisch.: 1) foliage; 2) branchlet with petioles of fallen leaves.—
 3. *Microbiota decussata* Kom.: branchlet.— 4 and 5. *Picea jezoensis* Kom.: 4) branchlet with petioles of fallen leaves; 5) branchlet with leaves and buds.— 6. *Picea Schrenkiana* F. et M.: branchlet with petioles of fallen leaves.— 7. *Juniperus seravschanica* Kom.: branchlet.—
 8. *Pinus silvestris* L.: portion of branch with two undeveloped branchlets.— 9. *Larix sibirica* Ldb.: branchlet of Siberian larch with five spurs.— 10. *Taxus cuspidata* S. et Z.: branchlet.— 11. *Pinus koraiensis* S. et Z.: portion of branch with one undeveloped branchlet.

occurrence of partial dioeciousness; male cones ovaloid, consisting of numerous scalelike scutate stamens, these bearing 3—7 bladderly pollen sacs; female cones of 3 or more scales, these becoming fleshy in maturity; seeds solitary on the ovulate scale, with woody coat; cotyledons 2.— More than 60 species, all in N. hemisphere.

Few fossil remnants are known: *Juniperus communis* L. reported (?) from Tertiary formations of Alt. (Chingistai); *J. sabina* L. from Quaternary formations of L. Don (Archeda). The genus was also reported, without identification of species, for Balkh. (Ashutas). Wood of *Juniperoxylon* Kalickii Jarm. is recorded for the Pliocene of Chelekan Peninsula (Caspian).

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10. Fruits larger, when ripe to 1 cm or even more in diameter, with a hard pericarp 11.
- + Fruits small, 2 or 5—8 mm in diameter, with a soft pericarp 16.
11. Leaves all spiny, even when appressed to the 4-angled branchlets; fruit reddish or brownish-black 10. *J. foetidissima* Willd.
- + Leaves on shoots exposed to light all imbricated 12.
12. Monoecious; bark dark gray; branchlets very slender, glaucous; leaves rather loosely appressed, hence branchlets apparently moniliform 11. *J. excelsa* M. B.
- + Dioecious; head brighter green; branchlets more even 13.
13. The slender branchlets bearing slightly appressed, dorsally concave, dark green glaucescent leaves 12. *J. isophyllos* C. Koch.
- + Leaves appressed, convex on the back, mostly light green 14.
14. Seeds commonly 4—6 in each fruit, castaneous, narrowly ovate, dentiform; branchlets rather massive 13. *J. polycarpus* C. Koch.
- + Seeds commonly 2—4 15.
15. Seeds mostly 3, dark, lustrous, often unguiculate; leaves with a very small round dorsal gland 14. *J. turcomanica* B. Fedtsch.
- + Seeds mostly 2 or 3, rarely 4, round or oblong, obtuse at apex and convex on the back, almost smooth, whitish and 2-grooved when unripe, becoming dark in ripening; leaves with an oblong dorsal gland 15. *J. seravschanica* Kom.
16. Seeds divergent at an acute angle, hence some fruits hemispherical and truncate at apex; branches often weeping 17.
- + Seeds always erect; shrubs with more or less trailing branches 19.
17. Branchlets rather short, strict; head dense, yellowish-green; seeds to 4.5 mm long, irregular in shape, with a keel and 2 lateral pits on the back 20. *J. schugnanica* Kom.
- + Branchlets slender, mostly pendulous; seeds to 5 mm long 18.
18. Fruits with a high sugar content, borne on long slender branchlets; head conspicuously weeping; seeds dark, subcastaneous 19. *J. talassica* Lipsky.
- + Fruits not sweet, borne on shorter branchlets; seeds lighter in color; head erect or weeping 18. *J. semiglobosa* Rgl.
19. Most branchlets with acicular leaves; scalelike leaves only at the ends of branchlets exposed to the sun 17. *J. dahurica* Pall.
- + Most branchlets clothed with scalelike leaves; acicular leaves exceptional 20.
20. Tree with a pyramidal head, cultivated *J. virginiana* L.
- + Shrubs of sands or rocks, with an irregular head 21.
21. Branchlets very slender, with a powerful odor; fruits small; seeds ovate; arenarious plant 21. *J. sabina* L.
- + Branchlets stouter, with less pronounced scent; fruits small; seeds trigonous; rupestral plant 16. *J. Sargenti* (Henry) Takeda.

Subgenus 1. **OXYCEDRUS** Spach, * Ann. Sc. nat. 2, ser. XVI (1841) 288.—Characters in the key.

1. *J. communis* L. Sp. pl. (1753) 1040; Pallas Fl. Ross. II, 12, tab. IV; Asch. und Gr. Syn. p. 1, 2 Aufl. 376; Shmal'g. II, 672; Syreishchikov,

* From Greek words oxys — sharp and kedros — cedar.

Mosk. Fl. I, 64; Kryl., Fl. Zap. Sib. I, 83 (only var. *vulgaris* Spach.).—*J. communis* var. *typica* Fomin, Vseukr. Ak. Nauk Trudi Mat. XI, (1928) 37.—Exs.: Fl. exsic. Austro-Hung., No. 1843.—Russian: mozhzhevel'nik obyknovennyi [common juniper] or veres; German: gemeiner Wacholder, Wacholder, Krammetsbeere, Kranawitt, Kronawett; French: genévrier commun; English: common juniper; Ukrainian: yalivets' zvichainyi; Lezghian: tsaru or tsyp; Ossetian: akhsali.

Tree, with an erect stem to 12 m tall, though mostly no more than 1–3 m, with grayish-brown scaly bark; branches erect to spreading, thus shape of the crown very variable; leaves linear, 4–16 or rarely to 20 mm long, long-pointed, shallowly channeled above, with a broad white median band, obtusely keeled beneath; fruits solitary, 7–9 mm in diameter, very abundant, round, one-fourth to one-third as long as the leaves, bluish-black; seeds 3, rarely 1 or 2, oblong-trigonus, brownish, ripening in the second year. Monoecious or mostly dioecious; fruits setting by the end of summer; male specimens have a narrower and more pointed head.

Pine woods, moorland, calcareous river banks; more rarely mossy, bogs, among undergrowth of deciduous and mixed woods, dry hills, and dry mountain slopes.—European part: from Murman Coast and upper reaches of Lozva River to Kiev, Kharkov, and Saratov; in Siberia from Nadym River at 66°N. lat. to Berezovo and the Yenisei estuary (Tolsty Nos at 180 70°10'N. lat.); in Yakut ASSR recorded for the Vilyni, Yakutsk and Olekminsk districts, turning N. and disappearing farther E. The S. limit runs from Nachinsk and Irkutsk, Angara Range near Nizhneudinsk, to Krasnoyarsk, Borovoe near Kokchetav, Saratov. In the Caucasus reported for the timber zone and for the foothills of N. Caucasus, Dagestan, Azerbaijan and part of Abkhazia (see next species). **Gen. distr.:** N. Africa, Centr. Eur. to Spain, Italy, and Turkey, N. Am. from Massachusetts to Alaska and New Mexico. Described from Scandinavia. Type in London.

Economic importance. Wood reddish, agreeably scented, used for lathework and sculpture, e. g., for furniture decoration. The fruit contains sugar and essential oil, used as diuretic and also in the liqueur industry (for export). Dry distillation of the wood yields empyreumatic juniper oil, Oleum cadinum, used against skin irritants. The resin gives sandarac and is used for the production of white varnish.

2. *J. oblonga* M. B. Fl. Taur. Cauc. II (1808) 426.—*J. communis* var. *oblonga* Medwed., Der. i kust. Kavk., 2nd ed. (1905), 27 and plates to page 28; b.—*J. communis* var. *caucasica* Endl. ex Medw. id.—*J. communis* proles *transcaucasica* Fom. in Vseukr. Akad. Nauk. Tr. Fiz. Mat. Vidd. XI, I (1928) 38.

A rather low tree, with dark gray bark; leaves in 3's, all acicular, hard, 16–20 mm long, 3-angled, glaucescent above, with a prominent midrib at base, keeled beneath right up to the apex, the keel occupying one-fourth the entire breadth; fruit globose with inconspicuous scale tip at the top (var. *globosa* Medw., *ibid.* 29) or else ovoid or ellipsoid (especially when unripe) with scales prominently tipped (var. *ovata* Medw. *ibid.*), all black, slightly pruinose; seeds 1–3, mostly 3, oval-oblong, obtusely 3-angled, brownish. A form also occurs with pendulous branches, but it has no other distinguishing characters; it has been described as *J. Wittmanniana* Stev. or *J. communis* var. *reflexa* Parl. (according to Medvedev).

Throughout the Caucasus from the Belaya and Laba rivers to Dagestan and the Turkish border, from the foothills to the upper timberline, in soils of all kinds, not avoiding even dry stony places.

Economic importance. Wood fine-grained, with reddish-yellow heartwood and whitish sapwood. Provides charcoal for gunpowder; used for small turned articles and as stakes for vineyards. Unripe berries are used for extraction of a yellow dye; ripe berries have diuretic and antiscorbutic action.

3. **J. depressa** Stev. in Bull. Soc. Moscou XXX (1857) 398; Medv., Der. Kavk., 2nd ed., 31; Vul'f, Fl. Kryma I, 41; Beissner Nadelholzsk., 2 Aufl., 619.— *J. communis proles depressa* Fom. in Vseukr.
181 AN Trudi Fiz. Mat. Vidd., XI, No. I (1928) 40.— *J. pygmaea* C. Koch Linn. XXII (1848) 302 pp.

A prostrate shrub with decumbent rooting branches; bark dark gray; branchlets yellowish-red; leaves straight, short, linear-subulate, 8–10 mm long and 1.5 mm broad, pruinose above, keeled beneath, the keel decurrent onto the bark of the branch and forming there an inflated pyriform resiniferous gland; male cones shorter than leaves; fruit black, pruinose, subsessile, shorter than leaves; seeds 2 or 3, trigonous, light brown, wrinkled.

Sometimes forming extensive thickets; growing in the zone of alpine meadows and pastures.— European part: Crimea, from the sources of the Alma River to the E. border of Yaila. In the Caucasus ubiquitous between 2,000 and 2,800 m, from the sources of the Laba to the Talysh mountains.
Gen. distr.: mountains of Bulgaria, N. Persia, and the borders of Turkey. Described from Chetyrdag in Crimea. Type in Helsinki.

Economic importance. Suitable for low hedges.

4. **J. sibirica** Burgsd. Anleit. 2 Aufl. (1790) 127, 128, No. 272.— *J. communis* var. *sibirica* Rydb. in Contr. U. S. Nat. Herb. III (1896), 533.— *J. nana* Willd. Sp. pl. IV (1805) 854.— *J. alpina* Clus Hist. pl. I, 38; Ldb. Fl. Ross. III, 683; Medv., Der. Kavk, 2nd ed., 33, with plate.— *J. communis* var. *nana* Loud. Arb. Brit. IV (1838) 2486; Kryl., Fl. Zap. Sib. I, 84.— *J. communis* var. *montana* Ait. Hort. Kew. III (1789) 414; Wilson. Conif. Tax. Japan, 80.— *J. communis pumila fruticosa* Pall. Fl. Ross. II, 12.— *J. pygmaea* C. Koch in Linnaea XXII (1849) 302.— *J. rebunensis* Kudo Med. pl. of Hokkaido No. 6, tab. 6; id. Fl. North. Saghalien (1923) 19.— *J. Niemannii* Wolf, Not. syst. ex Herb. Horti Bot. Petrop. III, 10 (1922), 37.— Russian: mozhzhevel'nik sibirskii; German: Zwerg- or Alpen-wacholder; French: genévrier nain; English: dwarf or alpine juniper, low juniper, fairy circles; Japanese: rishiri-byakushin.

A depressed dwarf shrub, with trailing or erect branches, very rarely arborescent, ca. 1 m broad; internodes abbreviated, to 1–4 mm long, hence leaf whorls approximate; leaves 4–8 mm long, more or less curved and appressed to branchlets, short-acuminate, channeled above, with a broad bright white median band, obtusely keeled beneath; fruit short-stalked, globose, black, pruinose, commonly longer than leaves, 6–8.5 mm in diameter; seeds 2 or 3, trigonous, reticulately wrinkled on the back, brownish.

Arctic and alpine zones, in mountains. European part: on Murman Coast in Khibiny mountains, etc., and on tundras of northern coast,

182 Kolgnev Island, tundras between Mezen and Pechora rivers (as far south as Ust-Sysol'sk), throughout Urals at the upper timberline. Caucasus: not below 2,400 m, from Kuban River to Adzharia; Centr. Asia: Tarbagatai, Tien Shan and Pamir-Alai Range; N. Siberia: Altai and Sayan mountains, Stanovoi Range. Far East: Anadyr, Kamchatka, Sikhote-Alin, Sakhalin. **Gen. distr.** : Kurile Islands, mountains of Hokkaido and Honshu, mountains of N. Korea, mountains of Mongolia and Tannu-Ola (rare), Asia Minor, and mountains of Centr. Eur. to the S. as far as Montenegro. Described from Siberia.

Economic importance. Wood as for *J. communis*. Fruits rich in sugar and may be used like those of the preceding species. Of importance as refuge for animals of commercial value.

5. *J. oxycedrus* L. Sp. pl. (1753) 1040; Beissner Nadelholzk. 3 Aufl. 526; Ldb. Fl. Ross. III (1851) 685; Medved., Der. i kust. Kavk., 2nd ed., 34, with table; Fom. in Vseukr. AN Trudi Fiz. Mat. Vidd. XI, I, 42; Vul'f, Fl. Kryma I, 43. — In the USSR only subsp. *rufescens* Asch. und Gr. Syn. 2 Aufl., I (1912) 384. — *J. rufescens* Link Sitzb. Ges. Nat. Berlin, Febr. (1845). — *J. Marschalliana* Stev. Verzeichn. (1857) 397. — *J. rhodocarpa* ibid. — Russian: mozhzhevel'nik krasnyi [red]; Georgian: gvia, gia, tvia; Armenian: gikhi; Tataric: dyshi-ardysh; German: spitzblättriger oder Cederwacholder; French: genévrier cade; English: prickly cedar; Italian: ginepro rosso; Croatian: smrik; Serbian: srvena fen'a.

Shrub or tree to 6 m tall and to 1 m in circumference; bark light gray, smooth, no young branches yellowish-brown; branches erect, spreading or ascending; branchlets green, short, obtusely 3-angled; leaves approximate, divaricate, linear, terminating in a long spiny point, 15–20 mm long, with two white bands, prominently keeled, eglandular; fruits solitary, subsessile, varying greatly in size from 6–7 mm long and 5–6 mm broad to 11–12 mm long and as broad, subglobose, glossy, brownish-red; seeds mostly 3 or 2, occasionally 1 or 4, broadly ovate, slightly trigonous.

Dry slopes, in the open or in thin woods, rising in the mountains up to 1,000 m, often on the margins of woods in stony soil. — European part: Crimea (from Sevastopol' to Feodosiya); Caucasus: from Raevska on the Kuban River and Anapa to Khevsuriya, Shiraki Steppe and Alagez. **Gen. distr.** : NW Persia, Turkish part of Transcaucasia, in the Balkan Peninsula and westward across the Mediterranean region as far as Madeira. Described from Spain. Type in London.

Economic importance. Wood reddish, with white sapwood, very durable; used for construction timber and carpentry; among other applications, employed for pencil-making. Fruits have stimulant and diuretic action, containing 1.5% of essential oil. As with other species, dry distillation of the wood yields a brown oily fluid, oleum eupyreumaticum cadinum, which is used as an anthelmintic and is applied against dermatitis. An excellent ornamental tree for gardens of the dry South.

6. *J. rigida* Sieb. et Zucc. Fl. Jap. II (1842) 109; Beissner Nadelholzk. 2 Aufl. 615; Kom. AHP XX, 207. — Ic. : Sieb. et Zucc., l. c., t. 125; Wilson Conif. of Japan (1916) 82, tab. LVIII. — Russian: mozhzhevel'nik tverdo-listnyi [hard-leaved]; German: steifblättriger Wacholder; French: genévrier rigide; English: stiff-leaved juniper; Japanese: muro or netsu.

183 Tree from 1 to 8 m tall (in Japan exceptionally up to 15 m), with a thin oval head; bark reddish-brown shading off to gray; branches 3-angled; leaves strict, narrowly linear, conspicuously spiny-pointed, narrowly channeled above, with a narrow white line, keeled beneath, to 2.8 cm long; fruits solitary, globose, smooth, not more than 6 mm in diameter, blackish-blue, with a bluish bloom; seeds 2 or 3, oblong, trigonous.

Single trees occurring in the S. Ussuri part of the Far East, on Suchan, along Suifun River and in Pos'et District; growing on mostly precipitous rocks, with preference for calcite formations. Described from Japan. Type in Munich.

7. *J. litoralis* Maxim. in Bull. Acad. Petersb. XII (1868) 230; Beissner Nadelholzk. 2 Aufl. 614. — *J. conferta* Parl. Conif. nov. I (1863) et in DC. Prodr. XVI, 2 (1868) 481; Miyabe et Kudo, Fl. Hokkaido and Saghalien (1930). — Ic.: Wilson, Conif. of Japan, 83 et tab. LIX. — Russian: mozhzhevel'nik primorskii [coastal]; Japanese: khai-netsu.

A prostrate shrub with long trailing branches; bark dark; branches thick, hard; foliage very dense, glaucous-green; leaves straight, linear-subulate, channeled above, with a white line at the bottom of the groove, convex beneath; fruits shorter than leaves, dark blue, strongly pruinose, dull, larger than peas; seeds 3, trigonous-oval, with oblong dorsal pits.

Coastal quicksands (dunes), forming vast blankets. — Far East: Sakhalin at Mauki and Ushoro near the 50th parallel. **Gen. distr.**: the islands of Honshu and Hokkaido. Described from Wright's specimen collected in 1854 in Hakodate.

Economic importance. Recommended for consolidation of dunes. Already cultivated in North America.

Subgenus 2. **SABINA** Spach, l. c., 291. — Siberian junipers. Characters in the key.

Series 1. **Sabinae monospermae** Kom. — One-seeded junipers.

8. *J. turkestanica** Kom. in Not. syst. ex Herb. H. B. Petrop. V, 2 (1924) 26, 27. — *J. pseudosabina* V. D. Dimitriev, Kiparisovye Sr. Az. 1930, 12.

184 Tree to 18 m (averaging 8 m) or low shrub to 2 m tall; head dense; bark brownish-gray, thinly scaling; branches suberect to horizontally drooping; leafy branchlets erect, 1.5–2 mm thick; leaves 2 mm long, oval, sharp-pointed, with a prominent dorsal gland, rarely eglandular, prominently keeled and obtuse-tipped; fruit juicy, with a high sugar content, globose or oblong, 10–15 mm long, 8–10 mm broad, black, glossy, slightly pruinose; seeds oblong to globose-oblong, tapering toward base, obtusely rounded at apex, sometimes slightly concave at the middle, rarely flat, very rarely short-pointed, 6–10 mm long, 5–7 mm broad, with a dark shiny strip in upper part and lateral grooves, the woody coat very thick. Some trees are aged 300–500 years.

* Known by local names "uryuk-archa," i. e., apricot juniper, on account of the sweet taste of the fruits; "tasva-archa," i. e., bead juniper, since beads are made of the seeds; "balkh-archa."

Growing in the upper timber zone of Pamir-Alai and Tien Shan, forming juniper woods by itself or mixed with *J. semiglobosa*, etc., from Kopal to Zeravshan, at altitudes of 900–3,200 m. Described from Tien Shan. Type in Leningrad.

Note. Four varieties or forms are known: 1) *fruticosa* Kom., a shrubby high-mountain form, less than 2 m tall irrespective of age; 2) *squarrosa* Kom. (spreading) — all leaves acicular, longer, often pruinose; branches strict; 3) *trisperma* Kom. — a big shrub, with typical branches and leaves; fruits less juicy, globose, ca. 8 mm in diameter, with a more developed glaucous bloom; 3-seeded, with 2 seeds connate, the third free, the dorsal face of the seed convex, the ventral flat, the apex obtusely rounded; 4) var. *lepidocarpa* Ruprecht, Sert Tiansch. (1869) 72 (sub. var. *J. pseudosabinae*). Fruits rough at the top with free projecting scale tips, smooth below. Deformities occur also in other juniper species.

Var. *fruticosa* and var. *squarrosa* grow in the subalpine zone, about the upper limit of woody vegetation, in mountain valleys, developing a hemispherical mass of branches on the up-valley side, while the opposite side of the shrub remains thin below, half-naked; var. *trisperma* Kom. was collected in Karategin in the Sugran River valley, in the proximity of glaciers, at an altitude of 2,650 m.

9. *J. pseudosabina* Fisch. et Mey. Animadv. "ad Index seminum H.P." 8 (1842) 15; Turcz. Fl. baic.-dah. II, 146; Ldb. Fl. Ross. III, 682; Kom. in Not. syst. ex Herb. H. P. V, 2 (1924) 26; Kryl., Fl. Zap. Sib. I, 87. — Russian: mozhzhevel'nik lozhnokazatskii; Altaic: ars, arsa.

Trailing shrub with decumbent or ascending branches, the terminal branchlets to 1.5–2 mm thick; leaves 1.5–2 or rarely 3 mm long and 1.5 mm broad, obtusish, subelliptic, the adaxial side concave, the abaxial side convex, the dorsal gland ovate or oblong; ocicular leaves lanceolate, long-pointed, strict; fruits ovoid, 5–8 or rarely 5–12 mm long, brownish-black, sometimes slightly pruinose; seeds ovate, smooth, 5 mm long and 3 mm broad. Monoecious.

In the alpine zone, on bare peaks and in stony places, on taluses and 185 rocks, in groups. — Siberia: Altai, Sayans, mountains of Transbaikalia; Centr. Asia: Tarbagatai, Aleksandrovskaia [Kirghiz] Range. Gen. distr.: mountains of Mongolia and Tannu-Tuva (Tannu-Ola).

Note. In westerly direction it becomes replaced by the larger *J. turkestanica* Kom.

Economic importance. Wood straight-grained, very translucent, suitable for working and used to some extent as construction timber; the heartwood is colored reddish-brown.

Series 2. *Sabinae polyspermae lithocarphae* Kom. (*excelsae*). Many-seeded junipers with hard pericarp.

10. *J. foetidissima* Willd. Sp. pl. IV (1805) 853; Medv., Der. Kavk., 2nd ed., with table, 43; Beissner. Nadelholzk. 3 Aufl. 602; Fom., Vseukr. AN. Tr. Fiz. Mat. Vidd. XI, 1, 49; Vul'f, Fl. Kryma I, 47. — *J. phoenicea* Pall. Fl. Ross. (1788) 16. — Ic.: Pall., l. c., t. 57; Antoine Die Cupr. Gatt. 49, tab. LXVII, LXVIII and LXXI. — Russian: mozhzhevel'nik vonyuchii [fetid]; local: ostrocheshuichatyi [sharp-scaled] m.; Georgian: tvia; Armenian: tsrtneni; Tataric: ardysh, erke-ardysh; Turanian: sel'vi-agach.

Tree with a pyramidal head, to 16.5 m tall; bark gray, when young brownish-red; branches often arched-recurved; branchlets subtetragonal, thickened; acicular leaves ovate or lance-acuminate and spiny-pointed, sometimes only the latter (var. *squarrosa* Medw.), imbricated, ovate or oblong-rhombic, often eglandular; fruits borne on a straight short stalk, globose to ovoid, large, reddish-black, pruinose; seeds 1 or 2, rarely 3, oval or ovate, pale castaneous. Dioecious. Living up to 300 years.

European part: in Crimea only on the N. slope, among beech woods; Caucasus: surroundings of Novorossiisk; in Georgia and Armenia, especially along the Kura River and in the Karabakh region. Growing exposed in dry argillaceous gravelly soil and on rocks, rising in the mountains up to 1,600 m. **Gen. distr.**: Turkey, Syria, Balkans, and Cyprus.

Economic importance. Wood firm, rather rigid, highly valued as construction timber. Resistant to insect damage.

11. **J. excelsa** M. B. Fl. Taur. cauc. II (1808) 425; Ldb. Fl. Ross. III, 682; Beissner Nadelholz. 3 Aufl., 600; Vul'f, Fl. Kryma I, 45; Shmal'g. II, 673; Fom., Vseukr. Ak. Nauk. Trudi Fiz. Mat. Vidd. XI, i, 46; B. and O. Fedch. in Tr. Bot. sada, XXXVIII, 41. — *J. sabina* Pall. Fl. Ross. II, (1788), 17 (p. p.). — *J. phoenicea* Pall. Fl. Ross. II, 16, tab. VII. — *J. taurica* Lipsky in Knorr. and Minkv., Rast. Aulie-Atinsk. u. (1912) 185–86. — Ic.: Medv., Der. i kust. Kavk., 2nd ed., 38. — Russian: mozhzhevel'nik vysokii [tall]; German: hoher Sadebaum; French: genevrier d'orient; English: Greek or Crimean juniper; Crimean: samn; Georgian: dedaligvia; Kirghiz: archa; Tadzhik: burs.

186 Tree to 10 m tall, with pyramidal bluish-green head; bark dark gray, scaly, peeling off; young branches brownish-red, rounded-tetragonal, very slender; leaves on branchlets divergent at the tips, ovate, acuminate, with a long spiny point, the dorsal gland oblong; trees occur with strict acicular leaves (var. *squarrosa* Medw.); leaves of young branchlets very small, glaucous, imbricated, oblong or ovate, with ovate to suborbicular gland; fruits solitary, globose, black, pruinose, 9–12 mm in diameter; seeds 5–8, rarely 3 or 4, oblong-ovate, obtusely striate, glossy, castaneous, the upper part of abaxial face wrinkled. Monoecious.

Dry sunny slopes, preferably with calcite soils, in the lower mountain zone. — European part: S. coast of Crimea from Balaklava to Sudak; Caucasus: Surroundings of Novorossiisk along the seacoast, from Anapa to Gelendzhik. **Gen. distr.**: islands of the Greek archipelago, Asia Minor, and Persia.

Economic importance. Wood resinous, reddish, very hard and rot-resistant, emitting a pleasant fragrance when burning, provides durable material for building and carpentry; also used for pencil-making. Lives up to 200 years. Growing well in gardens and pleasure grounds and occasionally replacing cypress trees.

12. **J. isophyllos** C. Koch in Linnaea XXII (1849) 304; Vul'f., Fl. Kryma I, 48; Medv., Der. i kust. Kavk., 2nd ed., 40; Fom., Vseukr. AN Tr. Fiz. Mat. Vidd. XI, I, 47. — *Sabina isophyllos* Antoine Die Cupres. Gattung. (1865) 48. — Ic.: Antoine, l. c., t. LXIV–LXVI. — Exs.: Busch, Marcowicz, Woronow, Fl. cauc. exs. No. 331.

Tree 4–7 m tall, occasionally reaching a height of 12 m; bark scaly, gray, on young branchlets reddish; leaves dark green, glaucescent, ovate

or oblong, subobtusate to acute, the concave dorsal gland oblong-ovate, the margins covered with white resinous exudation; fruits short-stalked, solitary or in groups of several, large, bluish-black, with a thick white bloom, globose; seeds 4 or 5, ovate-oblong, ribbed, reddish-brown, lustrous. Dioecious.

Rising in the mountains to 1,250 m; growing on dry and often stony mountain slopes of Transcaucasia and Crimea.— European part: in Crimea, in the lower zone of the S. slope of the range from the Baidarskaya Valley to Sudak; Caucasus: reported for the Shiraki Steppe near Mtskheta, on Bozdag Range, in Dagestan and in Artvin District. **Gen. distr.**: mountains of S. Persia and Asia Minor. Described from Armenia.

Economic importance. Ornamental, recommended for pleasure grounds in arid locations.

13. **J. polycarpus** C. Koch. in Linnaea XXII (1849) 303; Medv., Der. i kust. Kavk., 2nd ed., 41; Fom., Vseukh. AN Trudi Fiz. Mat. Vid. XI, No. I, 48; O. and B. Fedch. in Tr. Bot. sada XXXVIII, No. I (1924), 41.— *Sabina polycarpus* Antoine Kupressinengattung. (1857) 47.— *J. macropoda* Boiss Fl. Or., V (1884) 709.— Ic.: Antoine, l. c., 187 t. LXXII, LXVI.— Russian: mozhzhevel'nik mnogoplodnyi or vostochnyi [many-fruited or eastern juniper]; kara-archa.

Tree to 6—7 m tall or a low shrub with a dense head; bark reddish-gray, scaly; leafy branchlets short, firm, rather stout; leaves on branches ovate or deltoid, long-pointed, on branchlets obtusish, rhombic or ovate-rhombic, acute to subobtusate, slightly keeled on the back, with an ovate inflated gland; fruits short-stalked, solitary or in groups, blackish-blue, pruinose (brownish-lilac when unripe), globose, large; seeds 4 or 5, ovate-oval, ribbed, brownish. Dioecious. Reaching an age of 150—200 years.

Growing between 300 and 2,500 m, as solitary trees or shrubs, sometimes together with other juniper species, forming so-called juniper forests, tolerant of dry stony soils. Wood suitable for building and carpentry. Caucasus: (arid regions) widely distributed in Azerbaijan, in E. part of Georgia, in Dagestan, in Armenia, e. g., at Lake Sevan. **Gen. distr.**: in adjoining districts of Turkey and in Persia as far as Muscat.

14. **J. turcomanica** B. Fedtsch. in Fl. Turcom. I, (1932), 15.

Tree to 6 m, with spreading head and reddish scaly bark; leafy terminal branchlets slender, even; leaves of branchlets contiguous, with a short mostly rounded free portion, strongly convex on the back; dorsal gland nearer the base, round or rarely ovate, short; leaves of primary and shaded branches in 3's, acicular, spiny, 5—7 mm long; flowers dioecious; fruits borne on short leafy stalks, globose, black, pruinose, ca. 1 cm in diameter; seeds 3—5 in each fruit, brownish, oval-oblong, often dentiform, strongly convex on the abaxial side, lustrous, ca. 6 mm long and 2.5 mm broad; some seeds deviate greatly in shape.

In open groves or isolated groups on dry mountain slopes. Centr. Asia: Turkmenistan, Bol'shoi Balkhan Range, Kopet Dag as far east as Gyaurs. Type in Leningrad.

15. **J. seravschanica** Kom. Journ. Bot. de l'URSS, XVII (1932), 481.—

Tree 5—10 m tall, with reddish or reddish-gray bark; head dense; branchlets rather slender and relatively short, 1.5 mm thick, slightly

moniliform or not so, yellowish-green or glaucescent; leaves oblong, acute, with an oblong gland; fruits ca. 1.2 cm in diameter, subglobose, strongly pruinose, very hard, with a woody pericarpic layer; seeds 2 or 3, rarely 4, erect, flat or trigonous-ovaloid, 6—7.5 mm long, the lateral ones
188 (both when only 2) broad, convex and almost smooth on the back, the middle ones wedged in between them, longitudinally furrowed, or else all three seeds ovaloid, with an obtusish point; young seeds white, often distinctly marginate owing to two furrows; mature seeds dark-colored, sometimes with persistent lateral grooves and marginate. (Plate VIII, Figure 7).

Forming juniper woods in lower and middle parts of the timber zone, in pure stands or mixed with *J. semiglobosa*. Centr. Asia: in Tadzhikistan and partly in Uzbekistan, northward to the N. slope of the Turkestan Range and the upper reaches of the Angren River, eastward to the W. border of Tien Shan, and westward to the SW spur of the Gissar and Kugitang ranges. **Gen. distr.** : N. Afghanistan.

Economic importance. Fruits large, but not juicy and with very low sugar content. Wood useful for joinery and carpentry. An ornamental tree recommended for control of sliding and erosion of mountain slopes.

Series *Sabinae nolypermae mollicarpae* Kom. Many-seeded junipers with soft pericarp.

16. **J. Sargentii** (Henry) Takeda ex Miyabe et Kudo, Fl. of Hokkaido and Saghal. (1930) 78.—*J. chinensis* var. *Sargentii* Henry in Elwes et Henry, Trees of Gr. Brit. and Irel. VI (1912) 1432.—*J. davurica* Fr. Schmidt in Mem. Acad. Sc. Petersb., ser. 7, XII, No. 2 (1868) 178.—*J. procumbens* Sarg. in Garden and Forest X (1897) 421 (non Siebold).—*J. chinensis* var. *procumbens* Takeda in Journ. Linn. Soc. XLII, 486; Miyabe et Miyake, Fl. Saghal. (1915) 593.—Russian: mozhzhevel'nik Sarzhenta; Japanese: miyuyama-ibukbyu-akushin, shimpaku, miyuyama-haibuyakushin.

A trailing shrub with a long main stem and a dense mass of lateral branches; leaves light green or glaucescent; acicular leaves lanceolate, convex on the lower side, stiffly pointing toward the tips of branchlets; scalelike leaves closely approximate, obtusish, glandular; fruits globose, dark blue or black, 5—7 mm long; seeds 2 or 3, rarely 4 or 5, oblong, subtrigonus, glossy, brown. Predominantly dioecious.

Far East: Seaside rocks, all along the coast in the S. part of Sakhalin; also collected on the Suchan River on the rocks of the Chandalaz Ridge.

Gen. distr. : S. Kurile Islands, Honshu, Hokkaido, Shikoku, Kyushu, Quelpart [Cheju] and Korea, everywhere on coastal rocks.

Economic importance. Recommended for cultivation as a soil cover. Introduced from seeds collected by Sargent in Muroran near Hakodate.

17. **J. dahurica** Pall. Fl. Ross. II (1788) 13; Beissner, Nadelholzk. 3 Aufl., 617; Kom. Acta H. P. XX, 208; Turcz. Fl. baic. -dah. II, 2, 145; Ldb. Fl. Ross. III, 683.—Ic. : Pall., l. c., t. V.—Russian: mozhzhevel'nik daurskii [Daurian]; local name: veresk kamennyi ["stony heather"]; Goldi: apa-ngkura.

189 Trailing shrub; branches ascending, some bearing acicular strict leaves, others, especially tips of branchlets more exposed to the sun, bearing

scaleglike rhombic acutish distinctly glandular leaves; fruits globose, small, 5–6 mm in diameter, dark brown, pruinose; seeds 2–4, ovoid-oblong, often exserted from the fruit (gymnospermy).

Rocky streams, the main stem buried in the upper layer of the soil; commonly among forests on mountain slopes, in small groups or solitary. Far East: Ze. -Bu., Uss., S. Yakutia (Maya, Nel'kan, Sutam); Transbaikalia, Selenga River valley. **Gen. distr.** : N. Mongolia, E. of the Selenga River.

18. **J. semiglobosa** Rgl. Descr. pl. nov. in Acta H. P. VI, 2 (1880) (in separatis 1879) 487, 488; Descr. pl., nov. a cl. O. Fedtschenko lectarum 1882, 81; B. Fedtschenko in Acta H. P. XXXVIII, I, 41; B. Fedch., Rastit. Turk. (1915) 38; V. Lipskii in Tr. po lesn. op. delu, XXX (1911) 33; Beissner Nadelholz. 3 Aufl. 617. — Russian: mozhzhevel'nik polusharovidnyi [semiglobose juniper]; local name: saur-archa (red archa).

Erect tree to 10 m tall, with a rather loose and narrow often weeping head; branchlets slender, pendulous; acicular leaves terete, with a white median band above, lustrous, long-pointed; imbricated leaves rhombic, obtusish, with an oblong dorsal gland, tightly appressed to the branchlets; flowers dioecious; fruits semiglobose, flatly truncate at the top, black, with scattered mealy bloom, 6–7 mm in diameter; seeds 4, ca. 5 mm long and 3 mm broad, flattish, cuneate or with convex abaxial surface and lateral grooves.

Growing partly by itself, partly together with other juniper species, forming thin juniper woods on dry mountain slopes, moraine deposits, and lakeshore terraces. — Centr. Asia: Tadzhikistan at Lake Kuli-kalon, Lake Iskander-kul', valley of Archa-maidan, etc., along Zeravshan River, Gissar Range, Uzbekistan along Turkestan Range, Kirghizia (w. district). Described from Saratag Valley. Type in Leningrad.

Economic importance. Wood reddish, used for pencil-making. Resin content higher than in other juniper species. The following types of wood are distinguished according to color: white "safet-archa," red "saur-archa" (this used for pencil-making), and yellow "sary-archa."

19. **J. talassica** Lipsky in Tr. eksped. issl. kol. raionov Az. R., II, Botan. issl., No. 6 (1912) 185; B. Fedtschenko, Rastitel'nost' Turk. (1915) 36; Acta H. P. XXXVIII, I (1924) 40. — Ic. : Lipsky, l. c., t. 28.

Tree to 12 m tall, with trunk diameter 0.3 m; dioecious; branches long, drooping or even weeping; branchlets approximate, pliable, 4-angled; leaves rhombic, imbricated, fleshy, subacute to obtuse, with an oblong dorsal gland; male aments erect or nearly so, borne on short branchlets, their scales nearly round, obtuse; fruits globose, exceptionally profuse, solitary on long slender branchlets, black, with a white waxy bloom; scales 4; seeds 4, ribbed and pitted, 3–5 mm long and ca. 3 mm broad. — Centr. Asia: Kazakhstan, mountains of Talass Ala Tau at sources of Kara-goin River, in groups on slopes.

Note. Though very similar to *J. semiglobosa*, the fruits are distinguished by an important economic character, in that they have a much higher sugar content.

20. **J. schugnanica** Kom. Journ. Bot. de l'URSS, XVII, (1932), 482.

A small tree, with a dense yellowish-green head; leafy branchlets slender, rather short, 1–2 mm in diameter; wood white; bark reddish-gray;

leaves tightly appressed, rhombic-ovate, acute, with an elongated dorsal gland; fruits globose or semiglobose, black, dull, slightly pruinose, profuse, ca. 6 mm in diameter, soft, with a low sugar content; seeds 2, divergent at an acute angle, irregularly ovate, keeled on the back, with 2 lateral oval pits, 4–4.5 mm long and 2–3 mm broad; rarely fruits 4-seeded.

Centr. Asia: growing on stony mountain slopes in E. Tadzhikistan (Pitkharf village in Shugman, etc.).

Economic importance. Used for fuel and as carpentry material.

21. *J. sabina* L. Sp. pl. (1753) 1039; Ldb. Fl. Ross. III, 681; Boiss. Fl. or. V, 708; Beissner Nadelholzk. 2 Aufl. 585, fig. 150, 151. — *J. lycia* Pall Fl. Ross. I, 1 (1788) 14. — *Sabina officinalis* Garcke Fl. Mittel- und Süd-Deutschland (1858) 387. — Ic.: Pall. Fl. Ross II, 15, tab. VI. — Russian: mozhzhevel'nik kazatskii ("Cossack"); German: gemeiner Sadenbaum oder Sevenbaum; French: genévrier sabine; English: Savin juniper; Kazakh: kara-archa; Altai: ars, arsa; Ukrainian: yalivets kazatskii; Polish: sawina, jalowiec; Georgian: gyuva; Kalmyk: khoni-artchan; Mongolian: khonin-artsa; local names: veres, akhra, artysh, krasnogryzhnik, krovogon, kazatskaya mozhzhukha, donskoi mozhzhevel'nik, mesyachnik.

Trailing shrub, dioecious; branches partly decumbent, partly ascending; leaves strongly odoriferous; acicular leaves lance-linear, spiny-pointed; imbricated leaves lustrous, rhombic to rhombic-lanceolate, acute to subobtuse, with a keel and an oval gland on the back; aments ovaloid, with round scales, pale yellow; fruits solitary, profuse, small, 6–8 mm long and 5–6 mm broad, rounded-ovate, brownish, pruinose, of 4–6 scales; seeds mostly 2, though occasionally 1, 3, 4, or 6, ovoid, prominently keeled on the abaxial side.

- 191 Growing on wind-blown sand, chalk, rocks, exposed southern slopes, and stony slopes of hills and low mountains, more often in the steppe than in the forest belt. The N. limit in the European part runs from the upper course of the Golubaya River and the Archadinskoe woodland on the Don River to Kamyshin and Orenburg [Chkalov], beyond this in Tarbagatai; in Siberia: in E. Altai and W. Sayans to Usa River; the S. limit takes in Crimea; Caucasus: in the mountains of the Greater Caucasus and on Adzhar-Imeretian and Trialetskii ranges, avoiding Armenia and Talysh; in Central Asia: delimited by Centr. Tien Shan, Dzungarian Ala Tau and Tarbagatai. Reports for Transcaucasia are erroneous. **Gen. distr.:** mountains of S. and Centr. Europe, Kuldja, and N. Mongolia. Described from Italy. Type in London.

Economic importance. Of medicinal value are the green branchlets *Summitates Sabinae* (*Herba Sabinae*, *Ramuli Sabinae*, *Frondes Sabinae*), containing 2–5 and up to 17% of volatile Savin oil, sabinol $C_{10}H_{15}(OH)$, used as emmenagogue and abortive agent. The action is so strong that in Germany, where it is considered to be a beautiful ornamental shrub, it is banned from general-purpose gardens, as being toxic.

J. virginiana L. Sp. pl. (1753) 1039. — Russian: mozhzhevel'nik jurskii; English: red cedar.

Tree, often dioecious, 12–25 m tall, with a dense head; juvenile leaves acicular, in 3's; leaves of mature branches tightly imbricated, ovate-rhombic, with an oval gland on the back; fruits relatively small but very

numerous, densely pruinose; seeds mostly 2, rarely solitary, ovate-angular, glossy, light-colored.

Cultivated in parks and arboretums of Transcaucasia and Soviet Central Asia, e. g., in Tashkent and in Chardzhon. Gives fully viable seeds.

Native in the eastern states of North America. Introduced in 1648 in Oxford. Described from Virginia and Carolina. Type in London.

Subfamily **Thujoideae** PILGER

Ripe cones woody; scales spreading at opening. Altogether 12 genera; in the USSR 3, including cultivated.

Genus **CALLITRIS** (= **FRENELA** MIRBEL) VENT.

Fossils have been reported of *Frenela* sp. from the Oligocene of M. Dnp. (Mogil'no, Volhynia).

Genus **WIDDRINGTONIA** ENDL.

This genus, at present African and Australian, is reported from Tertiary formations of the USSR as *Widdringtonites* sp. from Balkh. (Ashutas).

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Genus **THUJA*** TOURN.

Inst. 586, tab. 358.

Branchlets disposed in one plane; leaves shortly 3-angled, decussate, scalelike, the facial pairs flat, the lateral longitudinally folded; aments terminal, very small, spherical; cones at the ends of short leafy branchlets, consisting of a single pair (the upper) of sterile scales and 2-4 pairs of fertile scales; seeds oblong, wingless or with narrow lateral winglets and 2 oblong resiniferous glands; cotyledons 2. There are 6 known species from North America and East Asia. Fossil remnants of species apparently relating to this genus, such as *Thuites Ehrenwardii* Heer, have been reported from Tertiary formations of Uss. and Sakh.

T. occidentalis L. Sp. pl. (1753) 1002; Beissner, Nadelholzk. 3 Aufl., 474, Fig.; Syreishch., Moskovskaya flora I, 63.— Russian: tuya zapadnaya [western]; Ukrainian: tuyu amerikanskaya [American]; German: abendländischer Lebensbaum; French: arbre de vie ou cèdre blanc; English: American arbor vitae; Polish: zywotnik.

Shrub or tree to 8 m; leafy branchlets flat; facial leaves obovate, obtuse, with a tuberculate gland on the back; lateral leaves navicular, contracted laterally, acuminate, to 4 mm long; cones recurved, 7-13 mm long, smooth, green, becoming brown; seeds 3-4 mm long.

Native in Atlantic states of the U. S. A. and in Canada, where it reaches a height of 20 m. Grown in the USSR in gardens and pleasure grounds. The red wood provides excellent material for carpentry and is exceptionally durable. Yields a tincture against warts, an anthelmintic oil, and African

* The name occurs already in Homer's *Odyssey* and refers to a North African tree with aromatic wood.

sandarac. Frost-resistant, the leaves producing in winter a special protective red pigment. Described from Canada. Type in London.

Genus 43. **BIOTA** * D. DON.

in Lamb. descr. of the gen. Pin. 2, ed. II (1828) 129.

Branchlets disposed at a right angle to the branches, the two sides of the leafy branchlets about the same; cone-scales at first coarsely fleshy, at length indurated, dry, irregularly rupturing at maturity, bearing on the back a hornlike process to 2 mm long; seeds wingless, oblong-ovate. A single species.

193 **B. orientalis** Endl. Conif. (1847) 47; Medv., Der. Kavk., 2nd ed., 25, with plate; Fom. in Vseukr. AN Tr. Fiz. Mat. Vidd. XI, I, 34.— Russian: biota vostochnaya [oriental]; German: morgenländischer Lebensbaum; French: thuya de Chine; English: Chinese arbor vitae; Chinese: pian-fa; Japanese: kanotekashiva; Central Asian: saur, sanaur; Ukrainian: tuyu skhidna.

Tree to 3 m or shrub; bark dark gray, scaly; young branches yellowish-red; leaves bright green, sometimes pruinose, with loosely appressed sharp tips, on small branchlets tightly imbricated, with a narrow resinous gland on the back; stramineate cones subspherical; ovulate cones on short branchlets, oblong-ovoid, light brownish-lilac, pruinose; scales 6—8, decussate, the lower pairs larger than the uppermost, with 1 or 2 seeds on each scale. (Plate VII; Figure 17).

Cultivated in Transcaucasia: naturalized in Signakhi District ("raion") of [former] Tiflis District ("okrug"), where it grows in crevices of calcareous rocks. Some very old cultivated trees are known in Soviet Central Asia (Turkmenistan, Tadzhikistan and part of Uzbekistan). Apparently native in China. An ornamental plant, suitable for hedges, as it stands up very well to clipping. Described from China. Type in London.

Genus 44. **MIKROBIOTA** ** KOM.

In Not. syst. ex Herb. Horti Petrop. IV, Nos. 23—24 (1923) 178. Izvesten tol'ko 1 vid.

1. **M. decussata** Kom. *ibid.*; Fitz-Patrick in Sc. Proc. of the R. Dublin. Soc. XIX (1924) 234.

A low trailing shrub, less than 1 m tall; branches flat, dorsiventral; branchlets in one plane, always flattened; leaves all alike, not differentiated into facial and lateral as in *Thuja*, on fertile branchlets ovate, acute, 2 mm long and 1 mm broad, on other branchlets ovate, point-tipped, with an elliptic dorsal gland, on shaded branches inside the head acicular and eglandular; male cones terminal, ovaloid, pale yellow; mature ovulate cones ca. 6 mm long and 3 mm broad, their scales ca. 3 mm long; ripe seeds solitary, attached at center between the scale bases, erect, rounded-ovate, with a minute spine, smooth at apex, completely wingless; cone 1-seeded, dry, of

* From Greek *bios*, vital, vigorous, on account of curative properties attributed to this tree, which was in fact considered a symbol of immortality.

** From Greek *micros*, small, and *biota*, i.e., a small biota.

2 or 4 scales, these smooth on the outside, spreading almost horizontally at maturity, 2 of them with a projecting subulate point somewhat below the obliquely rounded apex; cotyledons 2. (Plate VII, Figure 22 and Plate VIII, Figure 3).

Far East: Growing above the timberline, on bald peaks of the Suchan River valley, in the S. part of Sikhote-Alin and the Ol'ga area, also on a bald peak near Chernigorka; reported for bald peaks in the upper reaches of Anyui (Dondon) and Khor rivers. Described from Suchan. Type in Leningrad.

194 **Economic importance.** It was cultivated in the Khabarovsk arboretum where it produced very ornamental trailing shrubs.

Genus **LIBOCÉDRUS** * ENDL.

The genus appeared already in the upper Cretaceous formations of Ze.-Bu., where *L. salicornioides* was also found in Tertiary formations of W. Georgia.

Subfamily **Cupressoidae** PILGER

Ripe cones woody, with peltate scales. The subfamily contains 2 genera, of these only one is cultivated in the USSR.

Genus **CUPRÉSSUS** ** (TOURN.) L.

Gen. pl. ed. I (1737) 294.

Leaves decussate, on old branchlets tightly closed; flowers monoecious, microsporophylls with 4 microsporangial anthers, distributed in a row at lower edge of fold of sporophyll; fruit from woody scutiform scales, pedicels of which are attached to stem, as it were in the center of a hollow sphere, the surface of which is formed by the folds of these scales, bearing externally in center of each a short cusp. There are 14 species in Eur., Asia and N. Am. in the warm-temperate zone.

C. sempervirens L. Sp. pl. (1753) 1002; Beissner, Nadelholzk. 3 Aufl. 515; Asch. und Gr. Syn. I, 2 Aufl. 366.— Ic.: Pall. Fl. Ross II (1788), 11, tab. III; Beissner, l. c., fig. 142.— Russian: kiparis vechozelenyi [evergreen cypress]; German: Cypresse; French: cyprès; English: cypress; Tataric: sel'va; Polish: cyprysowe drzewo; Bulgarian: zelenets; Armenian: nochi; Georgian: gundis-khe.

Tree to 25 m tall, with a very dense head; old bark dull brownish gray; leaves 3-angled, juvenile long-acuminate and spreading, on mature branchlets tightly appressed and obtuse; cones subpendulous, globose or rarely ovoid; scales 6—14, peltate; seeds 8—20, 5—7 mm long, narrow-winged, reddish brown, somewhat glossy; Fl. from January to April; fruits maturing in early spring of the following year. (Plate VII, Figure 14).

* From Greek libas, drop, and cedros, cedar, i.e., cedar exuding droplets of resin.

** A popular name for cypress in the writing of Greek and Roman authors.

Cultivated since 1787 in Crimea, where it was introduced from Constantinople [Istanbul], from the S. extremity of the S. coast to Karabag, 7 km S. of Alushta. Also in Imeretia, Mingrelia and Abkhazia, everywhere in gardens and in cemeteries.

Note. Varieties: 1) *horizontalis* Mill. (Dict. No. 2 (1768) (p. p.); branches spreading horizontally; head more or less pyramidal; growing wild in the mountains of N. Persia, Asia Minor, Cyprus, and Cyrenaica; rarely cultivated; 2) *pyramidalis* (Targioni-Tozzetti Obs. bot. dec. III—V (1808—10) 53.— *C. fastigiata* DC. Fl. Fr. (1815) 334). Branches ascending, tightly appressed to the stem, hence the head assuming a narrowly pyramidal upward-tapering shape.

Class II. **GNETALES** ENGL.

Flowers extremely various, diclinous by reduction, often dioecious; staminate flowers with at least 2 connate bracts and with 1—3 3-locular stalked synangia, often with rudimentary carpels; ovulate flowers with 1 or 2 integuments and an erect sporophyll, the integument of the sporophyll terminating in a long tubular process [tubillus, micropylar tubule]; embryo with 2 cotyledons; wood without resin ducts, with true vessels among tracheids; leaves opposite. Three families, Ephedraceae, Welwitschiaceae, and Gnetaceae, of these only the first in the USSR.

Family **EPHEDRACEAE** WETTST.*

Wettst. Handl. d. Syst. Bot. 1, Auf, 1903, 155.

Shrubs or trees with diclinous flowers, dioecious, sometimes monoecious; flowers in cones; staminate flowers comprising a column of stamens, this sometimes divided at apex; anthers sessile or subsessile, dehiscing by terminal pores; the staminal column subtended by scalelike bracts; ovulate cones of several flowers, each with 1, 2 or 3 ovules enclosed in an envelope or 2, 3 or 4 pairs of bracts; outer integument open at apex; inner integument terminating in an exserted tube [tubillus]; outer seed coat subcoriaceous or fleshy; seeds containing endosperm and 2 cotyledons.

Genus 45. **EPHEDRA** ** L.

Gen. pl. ed. I (1737) 312.

Shrubs or small trees, from 2—7 cm to 1.5—5 m tall, with jointed branches; leaves reduced to scalelike sheaths (except *E. ciliata*; flowers commonly dioecious, rarely monoecious; staminate flowers sessile or stalked, the staminal column subtended by decussate pairs of bracts; ovulate cones often

* Arranged by E. G. Bobrov.

** The plant's name occurring in the writings of ancient authors.

crowded in an inflorescence, sessile or stalked; ovules 1—3, covered by 2 integuments and subtended by 2—4 pairs of bracts, these more or less connate at base; ripe fruit a yellowish or red fleshy false berry or dry, surrounded by bracts.

- 196 **Economic importance.** Ephedra species contain in their young branches the alkaloid ephedrin, $C_{10}H_{15}NO$ and its various isomers (pseudoephedrin, methyl-ephedrin, etc.). Used in the Chinese pharmacopoeia. A popular medicament in the USSR, not tested scientifically. The local population of Soviet Central Asia makes use of the young branches as admixture of tobacco.
1. Fruit berrylike, fleshy (Section *Pseudobaccatae* Stapf.) 3.
 - + Fruit dry; bracts scarious, the scarious margin with a winglike processes (Section *Alatae* Stapf.) 2.
 2. Bracts of ovulate inflorescence with broad scarious processes; tubillus straight, to 3 mm long; shrub to 2 m tall 1. *E. strobilacea* Bge.
 - + Bracts of ovulate inflorescence with narrow scarious processes; tubillus reduced to 1.5 mm; shrub to 0.5 m high. 2. *E. lomatolepis* Schrenk.
 3. Stems trailing or scandent, to 5 m long; leaves to 3 cm long 3. *E. ciliata* C. A. M.
 - + Stems erect or ascending; leaves rudimentary, scalelike 4.
 4. Tubillus 4—5 mm long; staminate cones densely crowded, sessile; branchlets erect, stout. 4. *E. intermedia* Schr. et C. A. M.
 - + Tubillus 1—3 mm long 5.
 5. Subshrubs to 25 cm tall 6.
 - + Shrubs or trees to 1.5 m tall, with sessile staminate cones 8.
 6. Ovulate cones 2-flowered; tubillus straight or slightly curved 7.
 - + Ovulate cones 1-flowered; tubillus serpentinous 6. *E. monosperma* C. A. M.
 7. Subshrub 2—7 cm tall; branchlets straight 7. *E. Fedtschenkoii* Pauls.
 - + Subshrub 10—25 cm tall; branchlets often tortuous at the tips 5. *E. distachya* L.
 8. The inner pair of bracts of ovulate cones connate through two-thirds of the length 8. *E. equisetina* Bge.
 - + The inner as well as the outer pair of bracts of ovulate cones connate through only one-third of their length 9. *E. procera* F. et M.

Section 1. **ALATAE** Stapf., Die Art. d. gatt. Eph. (1889) 35.—Ripe fruits dry, winged; bracts almost completely membranous except for the woody back, laterally winged, free or nearly so.

1. *E. strobilacea* Bge. Mem. d. Sav. étrang. VII (1851) 499.—*E. alata* auct. Fl. Turk. non DC.—Russian: khvoinik shishkonosnyi [cone-bearing]; Turkmenian: bordzhok.

- 197 An erect dioecious, much-branched shrub, to 2 m tall; bark gray, on old branches fibrillose; young branches to 4 mm in diameter, often verticillate, grayish green, smooth or somewhat scaberulous, the upper branches opposite; leaves in 2's or 3's, scalelike, acuminate, herbaceous, at the juncture membranaceous; staminate cones in capitate inflorescences,

borne at the nodes of young branches, elliptic, to 5 mm long; flowers 4–8, paired or in whorls of 3; bracts broad, to 2 mm long, connate at base, short-pointed, the margin broadly membranous, erose; staminal column short, little exserted; anthers 5 or 6, on filaments to 1 mm long; ovulate cones, like the staminate, borne at the nodes of young branches, spherical or ovoid, crowded in heads; bracts paired or in threes, in 5 or 6 whorls, free, rounded-obovate, herbaceous on the back, the margin broadly membranous, erose, ciliate; flowers in twos or threes, the straight tubillus to 3 mm long; fruit 6–7 mm long, with divaricate reflexed scales; seeds dark gray or greenish, 5–6 mm long, ovate or elliptic, slightly keeled on the back. Fl. May; fr. July. (Plate IX, Figure 2).

Sandy deserts. — Centr. Asia: Kara K., Kyz. K., Amu D. **Gen. distr. :** Persia. Described from Turkménistan. Type in Leningrad.

2. **E. lomatolepis** Schrenk in Bull. phys. -math. Acad. de S. Petersb. III (1845) 2.

Shrub to 0.5 m tall, with erect or ascending stems, branched at base, often with cauliform underground offshoots, these with abbreviated internodes to 1.5 cm long surrounded by sheaths to 6 mm long, the aerial extension developing into a normal shoot; branchlets stiff, green, to 2 mm thick, with middle internodes to 6 cm long, subverticillate, opposite above, smooth or scabrous, finely sulcate; bark of stems and of old branches brown, splitting; leaves in twos or threes, reduced to sheaths, to 4 mm long, herbaceous on the back, green, narrowly scarious and light-colored at the juncture, triangular and pointed at apex, the lower sheaths to 5 mm long, with scalelike lanceolate teeth; staminate cones gathered in a capitate inflorescence, spherical, to 6 mm long; flowers 4–8, solitary or in pairs; bracts broad, 1.5–2 mm long, short-acuminate, connate up to the middle, broadly membranous; staminal column only slightly exserted; anthers 6–8, with filaments to 1 mm long; ovulate cones solitary or crowded, sessile or pedunculate, at the base of branches or at the nodes, the peduncles sometimes to 5 cm long, bearing 3 or 4 cones; bracts in pairs or in 5 imbricated whorls, free or nearly so, broadly ovate or orbicular, obtusish, thicker and herbaceous on the back, the membranous margin slightly erose or entire; 198 flowers in twos or threes; tubillus twisted, to 1.5 mm long, ligulate or spoon-shaped at apex; fruit globose or ovaloid, light brown, to 6 mm long; bracts loosely imbricated, thickened on the back, to 5 mm in diameter, dry; seeds brown, planoconvex, ca. 4 mm long. Fl. May; fr. July. (Plate IX, Figure 1).

Sands. Centr. Asia: Balkh. (sands of Balkhash area and Muyun Kum). Described from Balkhash. Type in Leningrad.

Section 2. **PSEUDOBACCATAE** Stapf. — Die Art. d. Gatt. Eph. (1889) 35. — Ripe fruits with wingless bracts.

3. **E. ciliata** C. A. M. Monogr. Gatt. Eph. (1846) 100. — *E. foliata* Boiss. Fl. or. V (1884) 716. — *E. kokanica* Rgl. Acta HP. VI, 2 (1880) 479. — Exs. : HFR, No. 448.

Shrub with trailing or scandent stem to 5 m long, the bark gray, fibrillose; young branchlets glaucescent, verticillate, sulcate, to 3 mm in diameter, the internodes up to 8 cm long; leaves in twos, sometimes in



Plate IX

1. *Ephedra lomatolepis* Schrenk.: a) ovulate cone; b) bracts. — 2. *E. strobilacea* Bge.: a) ovulate cone; b) bracts. — 3. *E. ciliata* C.A.M.: ovulate cone. — 4. *E. Fedtschenkoi* Paulsen: ovulate cone. — 5. *E. monosperma* C.A.M.: ovulate cone.

threes or even in fours, to 3 cm long, linear, ca. 1 mm broad, acuminate, connate at base into a short membranous sheath, this distinct when young; staminate cones several in an inflorescence, on unequal peduncles of 2 or 3 internodes, ovoid, containing 4–6 pairs of flowers, 3–4 mm long; bracts round, obtusish, connate through one-third to one-half, to 2 mm long, scarious-margined, the inner ones broadly ovate and longer; staminal column scarcely exerted, with 3 or 4 sessile anthers; ovulate cones ovoid, borne on elongated peduncles in whorls of several; bracts 3 pairs, the lower connate through one-third, short, the middle ones twice as long, the uppermost connate through two-thirds, with exerted tubillus; all bracts round, obtusish, membranous-margined; flowers in twos or threes, barely exceeding the bracts, the straight tube ca. 1.5 mm long, short-ligulate at apex; anthers spherical, ca. 6 mm long; inner bracts fleshy, reddish or light-colored; seeds brown or blackish, exerted, to 6 mm long, convex on the back. Fl. May; fr. July. (Plate IX, Figure 3).

Lower mountain levels; trailing on slopes, sometimes climbing upon shrubs. Centr. Asia: Mtn. Turkm., Kara K. (SE), Pam.-Al. **Gen. distr.** Iran. Described from Persia (Gilan).

4. **E. intermedia** Schr. C. A. M. Monogr. Gatt. Eph. (1846) 88.—
 201 Shrub to 1 m, the strict branches connivent at the top, subparallel, densely forking, with gray fibrillose bark; branchlets straight, opposite or verticillate, to 2–3 mm in diameter, glaucescent, smooth or finely scaberulous, the internodes short or elongated (to 5 cm long); leaves paired, rarely in threes or fours, rudimentary, connate at base, scarious, triangular, to 3.5 mm long; staminate cones crowded in inflorescences to 1 cm in diameter, disposed along the branches, ovoid, ca. 6 mm long, with 3 or 4 pairs of flowers; bracts rounded-ovate, narrowly scarious-margined, connate through one-third, ca. 2.5 mm long, the inner ones longer; staminal column slightly exerted, entire or divided down to base; anthers 6–8, commonly short-stalked; ovulate cones 2- or 3-flowered, sometimes terminal; bracts 2 or 3 pairs, occasionally in whorls of 3, the lower ones (of 3 pairs) short, the middle ones (of 2 pairs) about as long as the inner ones, these connate up to or somewhat beyond the middle, broad, obtusish to subacuminate, narrowly scarious-margined, entire, the tube ca. 4–5 mm long, twisted, ligulate at apex; fruit globose, ca. 6 mm long, fleshy, red; seeds slightly exerted, brown, 5–6 mm planoconvex. Fl. June; fr. July.

Gritty slopes at lower mountain levels.— Centr. Asia: Mtn. Turkm., Pam.-Al., T. Sh., Dzu.-Tarb., Balkh.; W. Siberia: Irt., Alt. **Gen. distr.:** Dzu.-Kash., Tibet. Described from Tarbagatai. Type in Leningrad.

5. **E. distachya** L. Sp. pl. (1753), 1040.— *E. vulgaris* Rich. Comm. Conif. Syst. (1826) 26.— *E. monostachya* L. l. c. (p. p.).—
E. botryoides C. A. M. Monogr. Gatt. Eph. (1846) 99.— *E. dubia* Rgl. Acta H. P., VI, 2 (1880) 482.— *E. stenosperma* Schrenk in C. A. M. Monogr. Eph. (1846) 77.— Ic.: Rechb., Ic., t. DXXXIX, f. 1149.— Exs.: Fl. exs. Austro-Hung., No. 2288.— Khvoynik dvukholoskovyi [two-spiked], kuz'micheva trava, stepnaya malina [steppe raspberry], kizilcha.

Subshrub to 20 cm, with creeping rootstock, the short stem with dark gray bark; branchlets yellowish-green, spreading, straight or mostly curved at the tips, finely striate, minutely papillose on the striae, to 1 mm in diameter, the internodes to 3 cm long; leaves reduced to sheaths, these

brownish yellow on young branchlets, 1.5–2 mm long, cleft to one-third or one-half into 2 triangular lobes; staminate cones solitary, stalked or subsessile, ovoid; staminal column exserted; anthers commonly 8; ovulate cones ovoid, borne on short stalks (sometimes to 2.5 cm long), solitary or in clusters; bracts 3 or 4, the lower connate through one-third, broadly ovate, obtusish, narrowly membranous-margined, the inner connate to the middle, enclosing the tubillus, this straight, to 1.5 mm long, ligulate at apex; fruit berrylike, globose, 6–7 mm long, red; seeds ovoid or oblong-ovoid, 4.5–5.5 mm long, convex on the back below, dark brown. Fl. June; fr. July.

202 In the steppe, semidesert and desert regions, in the plains or on outcrops of parent rock, and on gritty slopes in mountainous locations. — European part: M. Dnp., V. -Don, Transv., V. -Kama, L. V. (S.), Bl., Crim.; W. Siberia: U. Tob., Irt., Alt.; Caucasus: Cisc., Dag., W. Transc. (NW), E. Transc. (E.); Centr. Asia: Ar. -Casp., Kara K. (surroundings of Krasnovodsk), Balkh., Dzu. -Tarb. **Gen. distr.**: N. Med. Described from S. Europe. Type in London.

At one time it was used as an infusion against gastritis and rheumatism.

6. **E. monosperma** C. A. M. Monogr. Gatt. Eph. (1846), 89. —

E. monostachya Turcz. Cat. in Bull. Nat. Mosc. (1838) 101. — *E. dahurica* Turcz. Fl. baic.-dah. II (1856) 148. — *E. vulgaris* Trautv. in Acta H. P. V, 2 (1877) 111 (non Rich. nec auct.). — Ic.: C. A. M., 1. c., tab. XI.

Shrub, with a long knotty flexuous caudex, a cluster of stiff ascending branches arising from the branched crown; branchlets yellowish green, ca. 1 mm in diameter, to 15–25 cm long, straight or curved, finely striate, the internodes to 2.5 cm long, the sheaths formed by 2 short rudimentary scarious leaves; staminate cones paired, obovoid, 4–5 mm long; anthers 6–8 on the exserted staminal column; ovulate cones borne on short recurved stalks; bracts 2 or 3 pairs, the lower connate at base, broadly ovate, narrowly membranous-margined, the upper (inner) somewhat shorter, connate to the middle; tubillus serpentine, 1.5–2 mm long, shortly bifid at apex; fruit berrylike, red, globose, 6–9 mm long; seeds ovoid, brown, 4–6 mm long, convex below on both faces (or, if 2 seeds present, planoconvex). Fl. June; fr. August. (Plate IX, Figure 5).

Stony slopes. — W. Siberia: Alt.; E. Siberia: Ang. -Say., Yen., Lena-Kol., Dau. Far East: Uss. Described from Lena.

7. **E. Fedtschenkoi** Paulsen in Bot. Tidskr. 26 Band (1905) 254. —

E. monosperma auct. fl. Turk. non C. A. M. — *E. monosperma* β *disperma* Rgl. in Acta H. P. VI (1879) 479.

Shrub with a flexuous underground caudex, the crown giving rise to a tuft of branches; branches ascending, yellowish green, ca. 1.5 mm in diameter, 2–7 cm long, straight or mostly curved, the internodes 1–1.5 cm long; sheaths of young branchlets greenish yellow, the component leaflets free in upper half, broad; old sheaths gray, brownish at base; staminate cones borne on a very short stalk, commonly 4- or 5-flowered; anthers 6–7, short-stalked or subsessile; ovulate cones short-stalked or sessile, solitary or paired, 2-flowered; lower bracts ca. 2 mm long, flattened, broadly ovate; upper bracts connate through one-third or up to the middle, broad, narrowly membranous-margined, reaching to the the middle of the fruit integuments; tubilli 2, exserted, straight or slightly curved, to 2 mm
203 long; fruit berrylike (red?), to 7 mm long; seeds planoconvex, dark brown,

glossy, ca. 4 mm long, one of them usually less developed. July—August. (Plate IX, Figure 4).

Pebbles and gravelly slopes, ascending into the high-mountain zone.— Centr. Asia: T. Sh., Pam. Al. (E.). **Gen. distr.**: Tibet. Described from Pamir (Lake Kara-kul').

Note. The separation of *E. Regelianae* Florin (Kungl. Sv. Vet. Akad. Handling. B. 12, No. 1 (1933), 17) from this species does not appear to us to be sufficiently substantiated.

8. ***E. equisetina*** Bge. Mme. d. Sav. étrang., t. VII (1851) 500.— *E. nebrodensis* Boiss. Fl. Or. V (1884), 714 (p. p.)

Shrub to 1–1.5 m tall, with a thick gray stem and stout branches; branchlets straight, strict, smooth, finely sulcate, 1.5–2 mm in diameter, with internodes to 2 cm long; leaves in pairs, rudimentary, almost scarious, connate through one-third or more, shortly triangular above; staminate cones solitary or in twos or threes, disposed along the branchlets, 2–4-flowered, 4–5 mm long, subspherical; outer bracts rounded-ovate, obtusish, connate through one-third, thin, narrowly marginate; inner bracts round, longer; staminal column scarcely exerted; anthers 6–8, subsessile, very rarely with short filaments; ovulate cones borne, like the staminate, on stalks 1–2 mm long, 1-flowered; bracts 2 or 3 pairs, the lower broadly ovate, narrowly scarious-margined, connate through one-third; inner bracts connate through one-third; tubillus straight or slightly curved, entire or lobed; fruit globose, 6–7 mm long, red, fleshy; seeds round, convex on both faces, 4–6 mm long. Fl. June; fr. June.

Caucasus: Dag., W. Transc.; W. Siberia: Irt., Alt.; Centr. Asia: Mtn. Turkm., Pam. -Al., T. Sh., Dzu. -Tarb. **Gen. distr.**: mountains of Central and Middle Asia, as far as Kalgan and Lake Kuku Nor. Described from W. Pamir-Alai. Type in Leningrad.

9. ***E. procera*** F. et M. Ind. X H. Bot. Petr. (1844), 45.— *E. nebrodensis* β *procera* Stapf. Die Arten der Gatt. Eph. (1889) 80.— Exs.: Fl. cauc. exs., No. 251.

Shrub to 1 m tall, with a low gray much branched stem; branches short and stout; branchlets straight, smooth, green, to 1.5 mm in diameter; sheath-leaves in opposite pairs, short, brown, thickened below, triangularly parted above, thin, almost scarious; staminate cones spherical, sessile, often crowded, disposed along the branchlets, 4–5 mm long, their bracts rounded-ovate, connate merely to one-third, scarious above, to 2 mm long; inner bracts rounded; greatly exceeding the lower; staminal column scarcely
204 exerted; anthers 6–8, sessile, the middle ones sometimes borne on filaments; fruiting cones short-stalked, oblong-ovate; bracts 2 or 3 pairs, narrowly marginate, the upper (inner) connate through one-third; flowers solitary; tubillus straight, ca. 3 mm long, oblongly ligulate at apex; fruit ovoid or globose, fleshy, red or reddish yellow; seeds brown, oblong-ovoid, 4–6 mm long. Fl. June; fr. July.

Dry gravelly slopes in the lower mountain zone.— Caucasus: Cisc., Dag., E. Transc., S. Transc. **Gen. distr.**: Bal. -As. Min., Arm. -Kurd., Iran, Him. Described from Tiflis. Type in Leningrad.

Subdivision II. **ANGIOSPERMAE**

Plants with a fully developed system of fibrovascular or conducting bundles, the xylem containing, in addition to tracheids, spiral, annular or latticed thick-walled vessels. Leaves fully developed, composed of blade, petiole, base, and stipules, or merely one or two of these organs. The microsporangia, also designated as anther locules, embedded in the anthers and 4 in number, at length fusing in the great majority of species into two. The microspores are formed in tetrads from the archesporium or pollen mother cells and the entire mass is designated as pollen. The macrospore consists of a single cell derived from the archesporium within the ovule. Its subsequent development leads to the formation of the embryo sac containing a rudimentary prothallium of 3 or more cells called the antipodes. The embryo sac contains a central nucleus formed by fusion of two polar nuclei. The upper part of the embryo sac contains a naked egg cell and two associate cells called synergids or satellites.

The microspores germinate on the stigma, forming a pollen tube which contains two spermatozoids at its end. The tip of the pollen tube penetrates into the ovule where, following the disintegration of the tip walls and a corresponding portion of the embryo sac, the spermatozoids [male gametes or sperms] penetrate into the embryo sac. One of the sperms fuses with the egg cell, the other with the central nucleus, thus forming two zygotes. The first zygote gives rise to the embryo, the other to the endosperm.

The seed consists of integuments or protective coats, endosperm and sometimes perisperm, and embryo. The embryo is composed of radicle, cotyledons, epicotyle, hypocotyle, and gemmule. The embryo is sometimes furnished with haustoria by means of which it draws nourishment from other parts of the seed.

205 The fusion of the sperm with the egg cell initiates the formation of the sporophyte, i. e., the diploid generation of cells capable of intensive division and full anatomical differentiation. Diploid constitution characterizes all the tissues of the flower (except pollen and embryo sac) and of the seed and, of course, the tissues of roots, stems, and leaves.

The first division of the cells of the archesporium in the anthers and ovules signals the haploid generation or gametophyte which consists of the pollen tube with their nuclei and the embryo sac, respectively.

Class I. **MONOCOTYLEDONEAE** DC.

Embryo with one cotyledon (spherical in some plants); endosperm mostly well developed; vascular bundles closed, without cambium, not increasing in thickness; leaves mostly with parallel or rarely pinnately disposed veins; flowers mostly of 5 trimerous whorls, though these numbers differ occasionally (Class 2, Dicotyledones; see Vol. V of the Flora of the USSR).

Key to Orders of Monocotyledones

1. Number of flower organs variable 2.
- + Flower consisting typically of 5 series, each of 3, rarely 2 or more than 3 identical organs 5.
2. Flowers mostly destitute of perianth, although transitions occur from fully achlamydeous condition to structures resembling calyx and corolla 3.
- + Absence of perianth occurring rarely and then of secondary nature, the strongly developed spathiform inflorescence bracts replacing the perianth as protective organ; the number of stamens and pistils mostly fixed, though not infrequently more than three 4.
3. Flowers in a compact spherical or cylindrical inflorescence; perianth represented by hairs or short green segments; palustrine or aquatic plants Order 1. **Pandanales**.
- + Flowers small, mostly 3-merous, in the axils of scales which form spikelets; fruit 1-seeded, with mealy endosperm; leaves nearly always linear Order 3. **Glumiflorae**.
4. Flowers mostly cyclic, with simple perianth and with parts in threes; stamens 6, rarely 3, 9 or indefinite; carpels 3; flowers in a branched spadix subtended by a spathe; arborescent plants, commonly unbranched; leaves palmatifid or pinnatifid, large Order 4. **Principes**.
- 206 + Flowers cyclic; perianth wanting or simple and inconspicuous of 2- or 3-merous series or reduced to a single stamen or single carpel, in a more or less compact spadix subtended by a large spathe; stem monopodial Order 2. **Spathiflorae**.
5. Stamens and pistils indefinite or solitary; perianth various or wanting; leaves stipulate. Order 2. **Helobiae** (or **Fluviales**).
- + Stamens and pistils definite, mostly in multiples of 3; stipules none 6.
6. Flowers cyclic, with simple or double perianth and parts in threes; seeds with starchy endosperm Order 6. **Farinosae**.
- + Seeds destitute of starchy tissue. 7.
7. Flowers regular or slightly irregular; seeds with oily endosperm Order 7. **Liliiflorae**.
- + Flowers mostly strongly irregular, zygomorphic, with 1 or rarely with 2 stamens; ovary decidedly inferior; seeds without endosperm. Order 7. **Microspermae**.

Key to Families of Monocotyledoneae

1. Perianth rudimentary, consisting of hairs, bristles or scales, or none 2.
- + Perianth corolline or at least some of its members petaloid, or perianth regularly calyculate 13.
2. Flowers subtended by scarious or scalelike bracts gathered in spikelets; fruit always 1-seeded; leaves linear, their lower part (base or sheath) amplexicaul; inflorescence a spike (cob in *Zea*), compound spike, or panicle (Order **Glumiflorae** C. A. Agardh) 3.
- + Flowers and inflorescence different from above 4.

3. Stem terete, distinctly nodiferous; leaves spirally disposed in two ranks; margins of the leaf base at the juncture of blade and sheath not united and on the inner side with a distinct ligular; scales of spikelets paired. Family XXIV. **Poaceae** or **Gramineae**.
- 207 + Stem not noduliferous; mostly 3-angled; leaves in 3 ranks; leaf sheaths closed; spikelets many-flowered or pistillate inflorescence consisting of 1-flowered lateral spikelets. Family XXV. **Cyperaceae**.
4. Unbranched trees; leaves large, long-petioled, the open blade palmatifid or pinnatifid. (Order **Principes**) Family XXVI. **Palmaceae**.
- + Herbs with undivided or rarely lobed leaves. 5.
5. Flowers small, in a compact cylindric or spherical spadix, or flowers so rare that plants apparently flowerless. 6.
- + Flowers not forming a spadix. 9.
6. Tiny aquatic freely floating plants with flat green foliaceous leafless stem (Order **Spathiflorae**) Family XXVIII. **Lemnaceae**. Family XXVII. **Araceae** [?]. 7.
- + Plants with fully developed leaves and flowers. 7.
7. Inflorescence more or less spherical and bristly, with radiating stigmas (Order **Pandanales**). Family XXVI. **Sparganiaceae**. 8.
- + Inflorescence cylindric. 8.
8. Tall erect plants; leaves broadly linear; inflorescence elongated, the upper part bearing pale yellow staminate flowers, the lower part tightly packed with short-pedicelled pistillate flowers. Family XXV. **Typhaceae**.
- + Inflorescence consisting of a fleshy spadix subtended by a spathe; flowers numerous, sessile; leaves ensiform or clearly differentiated into petiole and blade. (Order **Spathiflorae**).
9. Aquatic plants; flowers solitary or gathered in a spikelike inflorescence; perianth rudimentary, sometimes replaced by outgrowths of anther connectives (Order **Helobiae**). 10.
- + Paludic or terrestrial plants; perianth inconspicuous, scarious. 12.
10. Small submersed plants; leaves thin, opposite; flowers unisexual, with 1 stamen or 1 pistil and rudiments of a double perianth. Family XIX. **Najadaceae**.
- + Plants with submersed or partly submersed and partly floating leaves subtended by membranous stipules; flowers mostly in a spike, rarely solitary; stamens 2-4. 11.
11. Flowers diclinous, but gathered in a flat linear cluster; flowering cluster inclosed in the sheath of the uppermost leaf; pollen filiform. Family XVIII. **Zosteraceae**.
- 208 + Flowers bisexual, fully open at anthesis, in clusters with cylindric axes; pollen globose. Family XVII. **Potamogetonaceae**.
12. The entire plant consisting of a tuft of narrow subulate-tipped leaves and several slender peduncles bearing capitate inflorescences; flowers small, white, gathered in heads, surrounded by white bracts (Order **Farinosae**). Family XXIX. **Eriocaulonaceae**.
- + Flowers regular, stellate, small, green or brown to fulvous, gathered in glomerules; fruit a 3-loculed capsule; inflorescence essentially

- paniculate; leaves subulate or flat as in grasses and then the margins long-ciliate
- (Order **Liliiflorae**) Family XXXII. **Juncaceae**.
- + Flowers in a terminal raceme; fruit compound; carpels 1- or 2-seeded; leaves semiterete or flat, not ciliate
- Family XX. **Juncaginaceae**.
13. Flowers more or less regular, stellate, actinomorphic 14.
- + Flowers markedly zygomorphic 21.
14. Ovary inferior 15.
- + Ovary superior 18.
15. Aquatic plants with submersed or floating leaves; flowers diclinous, actinomorphic
- (Order **Helobiae**) Family XXIII. **Hydrocharitaceae**.
- + Terrestrial or paludose plants 16.
16. Twining, dioecious plants; flowers small, in axillary clusters; perianth 6-cleft, calyxlike; fruit a winged capsule or a berry
- (Order **Liliiflorae**) Family XXXV. **Dioscoreaceae**.
- + Plants with erect stems or scapes; flowers as a rule bisexual, with a rather large corollate perianth; fruit a wingless capsule 17.
17. Stamens 6; flowers actinomorphic; bulbous plants
- Family XXXIV. **Amaryllidaceae**.
- + Stamens 3; flowers actinomorphic or zygomorphic; rhizomatose or cormatose plants Family XXXVI. **Iridaceae**.
18. Carpels distinct; fruit compound 19.
- + Carpels united into a single ovary; fruit a capsule or berry 20.
19. Stamens 6 or numerous; flowers verticillate in an inflorescence, rarely solitary or in a simple umbel; leaves flat, petiolate
- (Order **Helobiae**) Family XXI. **Alismataceae**.
- 209 + Stamens 9; inflorescence umbelliform; leaves in lower part 4-angled Family XXII. **Butomaceae**.
20. Semiaquatic plants, with a large cluster of blue flowers and long-petioled ovate-cordate leaves; stamens unequal, the filaments adnate to the perianth tube
- (Order **Farinosae**) Family XXXI. **Pontederiaceae**.
- + Herbs with bulbs or creeping rhizomes, sometimes (*Smilax*) climbing high up the trees; all 6 stamens equal, the filaments free
- (Order **Liliiflorae**) Family XXXIII. **Liliaceae**.
21. Perianth of 3 green and 3 colored segments; stamens 6; ovary distinct, superior; stem nodiferous, geniculate; flowers blue or violet (Order **Farinosae**) Family XXX. **Commelinaceae**.
- + Perianth colored throughout, often with a hood and a lower lip, this in some genera saccate, in others spurred, in others still variously incised; ovary inferior, often spirally twisted; style united with the filaments into a fleshy column; anthers disposed symmetrically behind the column; capsule 1-loculed, with numerous minute seeds
- (Order **Microspermae**) Family XXXVII. **Orchidaceae**.

Order 1. **Pandanales**

Flowers diclinous, dioecious; perianth none or simple with bractlike segments; inflorescence spherical or cylindric; stamens and carpels solitary or numerous. Paludose trees or herbs with long linear leaves.

Family XV. **TYPHACEAE** J. ST. HIL. *

Aquatic or paludal plants; stems unbranched, terete; leaves 2-ranked; flowers unisexual, in a dense spikelike inflorescence; the upper part of inflorescence staminate, the lower part pistillate, both staminate and pistillate portion subtended by a foliaceous, promptly deciduous spathe; perianth none; male flowers with mostly 3 stamens, sometimes from 1 to 7, surrounded by filiform scales or hairs, the scales sometimes lacinate; female flowers sometimes bracteolate; ovary long-stipitate, the stipe clothed with bristles; abortive flowers sometimes present, these oblong-clavate or pyriform, terminating in a rudimentary stigma, borne on a hairy pedicel.

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Genus 46. **TYPHA** ** L.

Gen. ed. 1 (1737) 281.

Rootstock thickened, creeping, rich in starch, covered with two-ranked, promptly deciduous scalelike leaves. Stem without nodes. Leaves gathered at base of stem, vaginal, broad-linear or narrow-linear, entire, more rarely almost triquetrous. Pistillate and antheral parts of inflorescence contiguous or else more or less separated. Female spikes on small processes of inflorescence axis, sometimes taking the form of branchlets. Male spikes with stamens on simple filaments or 2—3 divided at apex. Anthers 4-loculed.

Remnants of Typhaceae have been preserved as indubitable imprints, as the presence of these plants in proximity of water favored their fossilization. *Typha latissima* A.Br. is known from Sarmatian formations of L. Don (Krynka).

1. Staminate and pistillate parts of inflorescence contiguous 2.
- + Staminate and pistillate parts of inflorescence separated by an interval 3.
2. The hairs much shorter than the stigma 1. **T. latifolia** L.
- + The hairs as long as or longer than the stigma 2. **T. orientalis** Presl.
3. Female spike ovaloid 4. **T. Laxmanni** Lep.
- + Female spike cylindric 4.
4. Female spike covered with bractlets 5.
- + Female spike without bractlets 3. **T. Veresczagini** Krl. et Schischk.
5. Plants 1 to 4 m tall; axis of male spike covered with hairs 6.
- + Plants not more than 1 m tall; axis of male spike destitute of hairs 8. **T. minima** Funk.
6. Leaves 3-angled; stigma lanceolate 5. **T. elephantina** Roxb.
- + Leaves flat; stigma linear 7.
7. Bractlets shorter than stigma 6. **T. angustifolia** L.
- + Bractlets as long as stigma 7. **T. angustata** Bory et Chaub.

* Arranged by B. A. Fedchenko.

** From Greek *typhe*, allied to *typhos*, bog, or from *typhein*, to burn, alluding to the apparently charred mature spike. The name *typhe* was already mentioned by Theophrastus and Dioscorides.

Section 1. **EBRACTEOLATAE.** Female flowers without bractlets.

1. **T. latifolia** L. Sp. pl. (1753) 971. — Ic: Rchb. fl. germ. IX, tab. 323, fig. 747, 748; Kronfeld Monogr. Typha, t. V, fig. 11. — Exs.: Tausch. Herb. Bot. No. 1577; Fl. of Osborn Count., No. 192.

211 Perennial; stems 100–200 cm, stout, terete; leaves broadly linear, to 20 mm broad, broader than in other USSR species; staminate part of inflorescence commonly contiguous with the pistillate part; filament of stamens 2–3 times as long as the anthers, these to 3 mm long; pistillate part slightly longer than the staminate, at maturity to 2.5 cm thick, cylindric, softly downy, blackish brown (thus readily distinguishable from the other species); ovary one-fourth to one-third the length of the stipe, this 3–4 mm long; stigma lanceolate or rhombic, greatly surpassing the perianth hairs. June–July. (Plate X, Figure 2).

River banks, backwaters, lakes, bogs, sites of peat cutting, and clays. — European part: all regions; Caucasus: all regions; W. Siberia: all regions; E. Siberia: all regions; Far East: Kamch., Sakh., Uss.; Centr. Asia: Ar. -Casp., Balkh., Syr D., T. Sh., Mtn. Turkm. **Gen. distr.:** Scand., Centr. Eur., Atl. Eur., Med., Bal. -As. Min., Iran., Arm. -Kurd., Dzu. -Kash., Mong., Jap. -Ch., N. Am. Described from Europe. Type in London.

Economic importance. This widely distributed plant is put to the same uses as the other large species of the genus. The rootstock contains a large amount of starch and may serve as a source for its extraction. The leaves are employed in cooperage and for weaving of baskets, mats, and rugs. Whole plants are used for paper-making and are ensilaged for feed. The inflorescence hairs are used for the production of excellent cellulose; they are also employed as packing and filling material; mixed with wool, they are used in the manufacture of felt for hat making.

2. **T. orientalis** Presl. Epimel. Bot. (1849) 249. — *T. japonica* Miq. Prol. Fl. japon. (1867) 324. — *T. latifolia* var. *orientalis* Rohrb. in Verh. Botan. Vereins Brandenb. XI (1869) 80. — Ic.: Kronfeld, Monogr. Typha, tab. IV, fig. 1. — Exs.: Cumming Philippin., No. 1767.

Perennial; stems 100–200 cm high, erect, firm; leaves linear, 0.5–1 cm broad, overtopping the inflorescence; sheaths somewhat convex on the back; inflorescence shorter than in the preceding species, the staminate part 4–5 cm, the pistillate 8–12 cm long; axis of staminate part covered with brownish hairs; female flowers borne on pedicels ca. 1.5 mm long; perianth hairs mainly at the flower base, equaling or exceeding the stigma and thus imparting a distinctive appearance to the fruiting spike. June–July.

Standing and sluggish water, and bogs. — Far East: only in Uss. **Gen. distr.:** Jap. -Ch. Described from the Philippines (Zebu Island). Type in Geneva.

3. **T. Veresczagini** Kryl. et Schischk. in Animadvers. system. ex Herbar. Univers. Tomsensk. (1927), No. 1.

212 Perennial; rhizome creeping, with long trailing offshoots; stem 70–115 cm high, erect; leaves rather regularly disposed on the stem, narrowly linear, 2–4 mm broad, sulcate, flattish toward the apex; inflorescence narrowly cylindric, the interval between the staminate and pistillate part 1.5–5 cm long, the staminate part shorter, 3.5–6 cm in length;

ovary of female flowers sessile or nearly so; perianth hairs half as long as the pistil. June—July.

Floodplains around lakes in Baraba Steppe. W. Siberia: Ob, Baraba Steppe. **Gen. distr.**: Endemic. Described from Baraba Steppe. Type in Tomsk; cotype in Leningrad.

4. **T. Laxmanni** Lepech. in Nova Acta Academ. Petrop. X (1801) 84, 335.— *T. stenophylla* F. et M. in Bull. Acad. St. Petersb., III (1845) 309.— Ic.: Lepech., l. c., tab. IV; Kronfeld, Mon. Typha tab. IV, f. 3 et tab. V, f. 15.— Exs.: Balansa, No. 103, Laxm., No. 66.

Perennial; more slender and shapely than the preceding; stem 80–130 cm high; leaves narrower, not more than 4 mm broad, greatly overtopping the inflorescence, the blade convex on the back; staminate and pistillate parts remote; axis of staminate spike covered with linear hairs; pistillate part of inflorescence oblong-ovoid, one-fourth to one-half as long as the staminate part, its axis together with flowers to 0.4 mm thick; perianth hairs obtusish, much shorter than the stigma. June—August.

Wet marshy places, most frequently in proximity of rivers and lakes.— European part: Bl., L. V.; Caucasus: Cis., Dag., W. Transc., S. Transc., E. Transc.; W. Siberia: U. Tob., Irt.; E. Siberia: Yen., Dau.; Far East: Uss.; Centr. Asia: Ar.-Casp., Balkh., Amu D., Syr D., T. Sh. **Gen. distr.**: Med., Bal.-As. Min., Mong., Jap.-Ch. Described from Transbaikalia. Type in Leningrad.

Section 2. BRACTEOLATAE. Pistillate flowers subtended by a bractlet.

5. **T. elephantina** Roxb. Fl. Ind. III (1832) 566.— *T. Maresii* Battand., Bull. Soc. bot. de France (1887) 389.— Ic.: Kronf. Monogr. Typha, t. V, f. 10.— Exs.: Clarke, No. 33442.

- 215 Perennial; stem 150–400 cm; leaves broadly linear, flat in the sheathing portion, angularly keeled on the back, hence apparently 3-angled and thus readily distinguishable from other species of the genus, in upper part flat, to 4 mm broad, about as long as the inflorescence; staminate and pistillate parts of the inflorescence remote; axis of the staminate spike clothed with dingy white hairs; pistillate spike cylindric, brown or blackish brown; abortive flowers present; bractlets of female flower narrowly spatulate, longer than the perianth hairs. June—July.

Riverside thickets.— Centr. Asia: Amu D.: in Amu Darya valley, near Kelif (discovered in 1916 by N. V. Androsov, collected in the same location in 1930 by L. A. Berezin). **Gen. distr.**: Ind.-Him., W. Med. Described from India. Type unknown.

Economic importance. This species has the same properties as other *Typha* species, but it is particularly suitable for exploitation owing to its enormous size.

6. **T. angustifolia** L. Sp. pl. (1753) 971.— Ic.: Fl. Dan. V, t. 815 Rchb. Ic. Fl. Germ. IX, tab. 321, f. 745.— Exs.: Rchb. Fl. germ. exs., No. 701; Tausch Fl. Boh., No. 1578.

Perennial; stem 100–180 cm; leaves flat or often slightly convex on the back, 4–6 mm or rarely up to 10 mm broad; inflorescence long-cylindric, the interval between the staminate and pistillate parts 3–8 cm long;

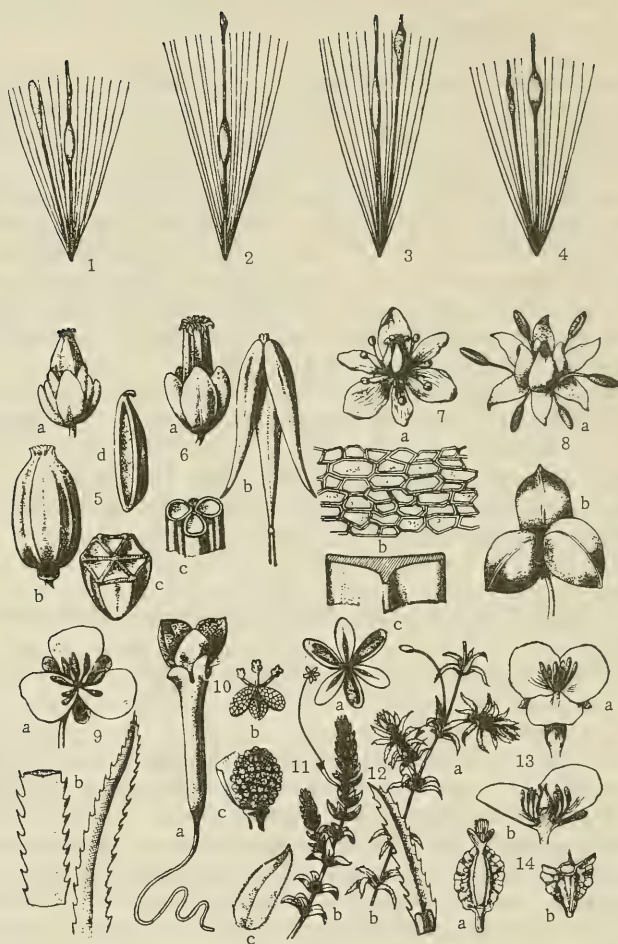


Plate X

1. *Typha angustifolia* L.: flower.— 2. *T. latifolia* L.: flower.— 3. *T. angustata* Bory et Chaub.— 4. *T. minima* Funk.— 5. *Triglochin maritima* L.: a) flower; b) fruit; c) cross section of fruit; d) longitudinal section of fruit.— 6. *T. palustris* L.: a) flower; b) fruit; c) cross section of fruit.— 7. *Butomus junceus* Turca.: a) flower; b) leaf epidermis; c) cross section of leaf.— 8. *Scheuchzeria palustris* L.: a) flower; b) fruit.— 9. *Statiotis aloides* L.: a) flower; b) leaves.— 10. *Vallisneria spiralis* L.: a) pistillate flower; b) staminate flower; c) staminate inflorescence.— 11. *Elodea canadensis* Rich.: a) flower; b) general aspect; c) leaf.— 12. *Hydrilla verticillata* Rich.: a) general aspect; b) leaf.— 13. *Hydrocharis morsus ranae* L.: a) flower; b) flower in section.— 14. *Ottelia alismoides* (L.) Pers.: a) flower; b) flower in section.

filaments half as long again to twice as long as anthers; bractlets of female flowers filiform, spatulately enlarged at the ends; ovary long-stipitate; stigma linear, greatly exceeding the perianth hairs and the bractlets. June—August. (Plate X, Figure 1).

Shores of rivers and lakes, backwaters, ditches, and clay pits in brickyards.—European part: all regions; Caucasus: Cisc., Dag., W., S. and E. Transc.; W. Siberia: all regions; E. Siberia: Ang.-Say., Day.; Centr. Asia: Ar.-Casp., Balkh., Dzu.-Tarb., Syr D. **Gen. distr.:** Scand., Centr. Eur., Atl. Eur., Med., Bal.-As. Min., Kurd.-Arm., Iran., Mong., N. Am.; also Cape Province, Canary Islands, and Australia. Described from Europe. Type in London.

Economic importance. Identical in its properties with *T. latifolia* and of similar economic value. In India it is also used for spinning coarse ropes, while the leaves are used to cover outhouses. An infusion of the root is used by Cossacks as an antiscorbutic remedy, while roasted rootstocks are used for food.

216 7. *T. angustata* Bory et Chaub. Exp. sc. Moree III (1732) 388.—*T. aequalis* Schnitzl. Typhac. (1845) 25.—Ic.: Kronfeld Monogr. Typh. tab. IV, fig. 6., tab. V, fig. 1.—Exs.: Belanger Herb. de l'Inde, No. 107; Sintenis Iter orient./1892, No. 4258; Heldr. Herb. graec. norm., No. 892; Sintenis Iter troj. 1883, No. 166 (s. n. *T. stenophylla*); Bornmüller Iter pers. turc., No. 4170.

Perennial, tall, robust plants, 150–300 cm high; stem rather stout, to 8 mm in diameter; staminate and pistillate parts of inflorescence commonly remote; axis of staminate spike hairy, the hairs pointed and toothed at apex; axis of pistillate inflorescence with pedicels to 1 mm long; bractlets as long as the female flowers; perianth hairs shorter than the bractlets; fruiting spike finally pale brown with gray spots formed by the tips of stigmas. June—July. (Plate X, Figure 3).

Wet waterside places.—European part: L. V.; Centr. Asia: Balkh., Kyz. K., Kara K., Amu D., Syr D., Pam.-Al. (foothills). **Gen. distr.:** Med., Bal.-As. Min., Iran., Dzu.-Kash., Mong., Jap.-Ch. Described from Morea [Peloponnesus]. Type unknown.

8. *T. minima* Funk in Hoppe, Botan. Taschenb. (1794) 118, 181 (nomen); Hoppe, *ibid.*, p. 187.—*T. angustifolia* var. *minor* L. Sp. pl. ed. 2 (1762), p. 603.—*T. Laxmanni* Ldb. Fl. ross. IV (1853), 3 (non Lepechin).—Ic.: Rchb. Ic. Fl. germ. vol. IX, tab. 319, fig. 742 et 743; Kronf., Monogr. Typha tab. IV, f. 2 et t. V, f. 7.—Exs.: HFR, No. 1892; Rchb. Fl. germ. exs., No. 1106; Schultz Herb. norm., No. 750; Kerner; Fl. Austro-hung., No. 687.

Perennial; very elegant plants, 30–60 cm high, with slender stem, readily distinguishable from other *Typha* species by its small size; leaves of sterile shoots very narrow, linear, commonly 1–1.5 mm broad; flowering stem surrounded at base by several short, bladeless, lance-tipped sheaths (a character distinguishing this species from all the others); staminate and pistillate parts of inflorescence usually remote; axis of staminate spike hairless; pistillate spike cylindric, sometimes somewhat enlarged toward apex, obconical, dark brown, the axis with pedicels 0.2–0.4 mm long; each flower subtended by a bractlet; perianth hairs as long as the bractlets. July—August. (Plate X, Figure 4).

Shores of rivers and lakes, and marshes. — Caucasus: Cisc., Dag., S. Transc., E. Transc.; Centr. Asia: Balkh., Syr D., Kara K., Amu D. **Gen. distr.:** Centr. Eur., Atl. Eur., Med., Bal. -As. Min., Arm. -Kurd., Iran., Dzu. -Kash., Mong., Jap. -Ch. Described from the Danube valley, near Salzburg. Type in Vienna.

Family XVI. **SPARGANIACEAE** ENGL.

Flowers in dense spherical female and male heads, the pistillate heads borne on the lower, the staminate heads on the upper part of a compound inflorescence; perianth of 3—6 scalelike segments; stamens 3 or often 5; 217 pistil commonly 1; ovary normally 1-locular (in our species), rarely 2-locular; fruit a drupe, with a hard seed and spongy or fleshy pericarp; seeds solitary in the locule, with well-developed endosperm and an erect embryo. Only 1 genus.

Genus 47. **SPARGANIUM** ** L.

L. Sp. Pl. 1 (1753) 971.

Plants with creeping horizontal rhizome prolonged into an aerial shoot; stem erect or floating; cauline leaves 2-ranked, alternate, elongate-linear, entire, sheathing at base, gradually replaced by the bracts of the inflorescence. Species of the genus *Sparganium* give rise to a large number of hybrids which display various combinations of characters of the parental forms and present serious difficulties for the beginner. Correct determination of the hybrids is only possible upon thorough acquaintance with the characters of pure species.

1. Perianth segments firm, dark-colored; leaves sharply keeled beneath; staminate heads numerous (Subgenus *Melanosparanium* Holmb.) 2.
- + Perianth segments thin, colorless; leaves not sharply keeled beneath, flat or 3-angled, rarely sharp-keeled and then staminate heads 1 or 2 (3) (Subgenus *Xanthosparanium* Holmb.) 7.
2. Inflorescence much branched, very rarely simple; pistillate heads on the primary axis pedunculate; stigmas more than 2 mm long (*Cycle Ramosa* Juz. = *S. ramosum* Huds. sp. coll.)† 3.
- + Inflorescence with 1 or 2 branches from the base; sessile pistillate heads always present on the primary axis; stigmas commonly not more than 1 mm long 6.
3. Fruit obpyramidal, the lower part polygonal in cross section, the top abruptly beaked (Series *Polyedra* Juz.) 4.

* Arranged by S. V. Yuzepchuk.

** From Greek *sparganon*, ribbon, band, in allusion to the leaf shape.

† When determining species belonging to the compound *S. ramosum*, that are chiefly distinguished by the shape and structure of the fruit, it should be noted that these species sometimes produce an ovoid-fruited form "f. *oocarpum* (*S. oocarpum* (Celak.) Ostenf. Hansen in Bot. Tidsskr. XXI (1897) V) characterized by broadly obovoid or sometimes subglobose fruits. This form is by no means equivalent to other species of this group and it arises when but few fruits develop in the heads. Precise determinations of such forms often presents difficulties; they are of no systematic significance.

- + Fruit fusiform, often constricted at the middle, the lower part round or obscurely angled in cross section, the top gradually tapering to a beak (Series *Neglecta* Juz.) 5.
- 4. The upper part of the fruit flattened or shortly pyramidal; the seed reaching the summit of the fruit 1. *S. polyedrum* Asch. et Gr.
- + The upper part of the fruit hemispherical; the seed not quite reaching the summit of the fruit 2. *S. stoloniferum* Buch.-Ham.
- 5. Fruit large, 6–11 mm long, not constricted at the middle 3. *S. neglectum* Beeby.
- + Fruit small, usually 5–6 mm long, constricted at the middle 4. *S. microcarpum* Čelak.
- 6. Leaves 2–3 (–6) mm broad; inflorescence with 1 or 2 branches from base (Cycle *Stenophylla* Juz.) 5. *S. stenophyllum* Maxim.
- + Leaves more than 6 mm broad; inflorescence always simple (Cycle *Americana* Juz.) 6. *S. japonicum* Rothert.
- 7. Leaves sharply keeled; pistillate heads sessile, rather crowded, strongly extra-axillary (Cycle *Glomerata* Juz.) 8.
- + Leaves flat or 3-angled, not sharply keeled; pistillate heads not crowded 9.
- 8. Pistillate heads tightly packed; staminate head commonly solitary, approximate to the upper pistillate head 10. *S. glomeratum* Laest.
- + Pistillate heads less crowded; staminate heads up to 3, borne on the more developed staminate part of the inflorescence (to 1.5 cm long) 11. *S. Glehnii* Meinsh.
- 9. Style rather long (in fruit not less than 2 mm); stipe of fruit 2–3 mm long 10.
- + Style wanting or not more than 1 mm long; stipe of fruit to 1 mm long (Cycle *Minima* Asch. et Gr.) 12.
- 10. Inflorescence often branched; style in fruit hooked from the base (Cycle *Friesiana* Juz.) 7. *S. Friesii* Beurl.
- + Inflorescence always simple; style in fruit more or less straight (Cycle *Simplicia* Juz.) 11.
- 11. Style together with stigma longer than the fruit excluding stipe; fruit 1.5–2 mm long; staminate heads numerous (more than 4), not crowded 8. *S. simplex* Huds.
- + Style together with stigma shorter than or rarely as long as the fruit excluding stipe; anthers short (0.75–1 mm long); staminate heads few (2–4), crowded 9. *S. affine* Schnizl.
- 12. Vegetative part of the stem consisting of 5–8 internodes; style present; pistillate heads axillary 12. *S. minimum* Hill.
- + Vegetative part of the stem consisting of not more than 5 internodes; style commonly wanting; pistillate heads partly extra-axillary 13. *S. hyperboreum* Laest.

Subgenus 1. **MELANOSPARGANIUM** Holmb. in Bot. Notis (1922) 206.

Perianth segments firm, dark-colored, mostly blackish brown.

219 Cycle *Ramosa* Juz. nov.—Leaves broad; inflorescence much branched, very rarely simple; pistillate heads on the primary axis pedunculate or wanting, the branches and heads axillary; style more than

2 mm long. — The species of this group are far from having been adequately studied, and their distribution is known only very roughly. In cases where precise determination is difficult on account of absence of fruits, use can be made of the compound name *S. ramosum* Huds. Fl. angl. (1778) p. 401; Ldb., Fl. Ross. IV, 3; Kryl., Fl. Zap. Sib. 97, this name embracing all forms of this cycle (in the original connotation — *S. polyedrum* and *S. neglectum*). Forms of the collective *S. ramosum* are known from nearly all regions of the Soviet Union, except the Arctic region and Kamchatka.

Series Polyedra Juz. nov. Fruit obpyramidal or obovoid, the lower part 4- or 5-angled and flat-faceted, the upper part clearly contrasted and abruptly short-beaked; seed deeply furrowed. — In addition to USSR species, this series includes the North American *S. eurycarpum* Engelm.

1. ***S. polyedrum*** Asch. et Gr. Syn. I (1897), 283 (pro subsp.). — *S. ramosum* Huds. Fl. Angl. ed. 2 (1778) 401 p. p.; Curtis Fl. Lond. V, pl. 66 et descr. et auct. mult. — Ic.: Čelak. in OBZ. XLVI (1896) tab. VIII; Rotert, Fl. Az. Ross. 1 (1913) 19; Bot. Not., (1897) 130 r.

Perennial; stem always erect, 25–150 cm high; leaves 1.5–2 cm broad, glaucescent, coriaceous, hard, prominently sharp-keeled beneath; inflorescence with numerous branches bearing 1–4 staminate and 10–20 pistillate heads; scales of female flowers broadly ligular, not dilated or scarcely dilated at apex, with or without a narrow light-colored coriaceous margin, not overtopping the fruit; style short; stigma linear, very long (3–4 cm) and slender; fruit sessile, obpyramidal, the length slightly more than the greatest diameter, the upper obtuse conical free upper part very short, the whole fruit including beak 5–10 mm long, 3.5–6 mm broad, dark brown or blackish brown; seed sharply angled, embedded in spony perianth tissue, reaching the summit of the fruit. June–August. (Plate XI, Figure 1 a–g).

Shores of lakes, rivers, backwaters, and ponds, sometimes in fairly deep water. — European part: U. V., V. -Kama, U. Dnp., M. Dnp., V. -Don, Bl., L. Don, L. V.; Caucasus: Cisc., Dag., E. Transc., Tal.; W. Siberia: Irt., Alt.; E. Siberia: Yen., Lena-Kol. **Gen. distr.**: W. Europe. Described from Centr. Europe. Type in Berlin.

2. ***S. stoloniferum*** Buch.-Ham. in Wallich Cat. (1832) No. 4990 (nomen), Graebner in Engl. Pflanzenr. IV, 10 (1900) 14. — *S. carinatum* Falc. in Proc. Linn. Soc. I (1839) 18 (nomen). — *S. asiaticum* Graebn. in Allg. bot. Zeitschr. IV (1898) 32 (nomen). — ? *S. coreanum* Levl. in Fedde 220 Rep. sp. nov. X (1912) 441. — Ic.: Graebn. in Engl. Pflanzenr. IV, 10, fig. 3 C.

Perennial; a smaller plant as compared to *S. polyedrum*, commonly to 1 m high; leaves 0.7–1.5 cm broad, somewhat less indurated than in *S. polyedrum*, prominently sharp-keeled; inflorescence commonly with 4–8 staminate heads and numerous pistillate heads; scales of female flowers narrowish, slightly dilated at apex, light brown, with a light-colored coriaceous margin, not overtopping the fruit; style and stigma as in *S. polyedrum*; fruit rather small, 5–6 mm long, ca. 4 mm in diameter, with obpyramidal base and hemispherical summit; seed deeply furrowed,

not reaching the summit of the fruit. Fr. May—July. (Plate XI, Figure 2 a—b).

W. Siberia: Irt.; E. Siberia: Dau.; Far East: Uss.; Centr. Asia: Ar.-Casp., Balkh., T. Sh., Pam.-Al. **Gen. distr.**: Middle and E. Asia, from Afghanistan to China and Japan. Described from East India (Magahor). Type in Calcutta.

Note. A little studied but undoubtedly widely distributed Asian type. Its forms need critical revision. Care should be exercised not to confound specimens of *E. polyedrum* of the "oocarpum" form (see footnote on p. 170) with *S. stoloniferum*.

Series Neglecta Juz. — Fruit fusiform, the lower part round or obscurely angled in cross section, the upper part not much contrasted or separated from the lower part by a constriction, gradually tapering into a rather long beak; seed shallowly furrowed or almost smooth.

3. *S. neglectum* Beeby in Journ. of Bot. XXIII (1885) 26, 193. — *S. ramosum* Huds, l. c., p. p. — Ic.: Beeby, l. c., tab. 258; Čelak., l. c., tab. VIII; Rotert, l. c., p. 19; Bot. Not. 1897, No. 130.

Perennial; stem usually somewhat shorter than in the case of *S. polyedrum*, sulcate; leaves 1.5–3 cm broad, pale green, very prominently and sharply keeled; inflorescence much branched, the very elongate branches with (1) 2 or 3 pistillate and 12–20 staminate heads; scales of pistillate flowers light brown, spatulately enlarged at apex, with a broadly light-colored coriaceous margin, overtopping the fruit; stigmas linear-lanceolate, 2–3 mm long; fruits sessile, obtusely fusiform, more than twice as long as broad, contiguous with other fruits only in lower part, the upper free part ovoid, the whole fruit 6–11 mm long, 3–4 mm broad, yellowish to light brown, rather dull. June—August. (Plate XI, Figure 3 a—f).

Shores of lakes, rivers, and ponds. — European part: Crimea, and dubious specimens also from U. V., V.-Dnp., M. Dnp.; Caucasus: Cisc., W. Transc., E. Transc., Tal. **Gen. distr.**: W. Eur., especially Atlantic countries, Med., N. Afr., Hither Asia as far as Persia inclusive. Described from England, Albury Ponds near Guildford (Surrey).

221 4. *S. microcarpum* (Neum.) Čelak. in OBZ XLVI (1896), 423. — *S. ramosum* f. *microcarpum* Neum. in Hartm. Scand. Fl. 12 Uppl. (1889), 112. — Ic.: Čelak., l. c., tab. VIII; Bot. Notis. 1897, 130; Rotert, l. c., p. 19. — Exs.: Pl. Finl., No. 422.

Perennial; stems shorter and weaker than those of *S. polyedrum* and *S. neglectum*. Leaves 1–1.5 cm broad, dark green, less indurated, less prominently keeled; inflorescence with fewer branches or rarely simple; pistillate heads 1–3 on each axis; staminate heads 5–12; scales of female flowers strongly spatulate at apex, dark brown, without a white coriaceous margin, slightly overtopping the fruit; stigmas linear, 1.5–2 mm long, narrow; fruit borne on a short to fairly long stipe, shortly and obtusely fusiform, constricted slightly above the middle, the lower part obtusely angled or almost round in cross section, somewhat broader, ovoid, brown, lustrous. June—August. (Plate XI, Figure 4 a—c).

Rivers, lakes, backwaters, ponds, along the banks and in shallow water, also in swamps. — European part: Kar.-Lap., Lad.-Ilm., U. V., V.-Kama,

U. Dnp., M. Dnp., V. -Don, Transv., Crim.; Caucasus: Cisc., E. Transc. (South Ossetia); W. Siberia: U. Tob., Irt., Alt.; Centr. Asia: Dzu. -Tarb., T. Sh. **Gen. distr.**: W. Europe, especially the N. parts, to the S. as far as Tyrol and Herzegovina. Described from the Czech Lands. Type in Prague.

Hybrids: *S. microcarpum* Čelak × *S. polyedrum* Asch. et Gr. apparently occur not infrequently in locations where the two species grow together.— *S. microcarpum* Čelak × *S. simplex* Huds.— an imperfectly authenticated specimen known from Lad. -Ilm. (Pavlovsk, near Leningrad).

Cycle *Stenophylla* Juz. nov.— Leaves very narrow; inflorescence, simple or with 1 or 2 branches from the base; pistillate heads usually sessile; stigmas short.— In addition to our species, this cycle includes the related *S. antipodum* Graebn. that grows in Australia and New Zealand.

5. ***S. stenophyllum*** Maxim. ex Meinsh. in Bull. Soc. Natur. Moscou, N. S. III (1889) 171.

Perennial; stem erect, slender, 20–40 cm long; leaves 2–3 mm broad, relatively thick and firm, keeled throughout, terminating in an obtuse slightly thickened black tip; inflorescence elongated, the branches (if present) bearing at most 1 pistillate head and several staminate heads, the principal axis bearing 2 or 3 pistillate and 6–12 staminate heads; all heads axillary; stigma lanceolate, to 1.25 mm long; fruit sessile, obpyramidal, 3–4 mm long, 2.25–3 mm in diameter, abruptly constricted into style. July. (Plate XI, Figure 5 a–c).

Shores of lakes and backwaters and grass-and-sedge bogs.— Far East: Uss. **Gen. distr.**: E. and S. Asia. Described from SE Manchuria, Nikol'sk area. Type in Leningrad.

222 Cycle *Americana* Juz. nov.— Leaves broad; inflorescence simple; lower pistillate heads pedunculate; stigmas short.— The cycle is named after the leading species *S. americanum* Nutt. which is related to our representative of this group.

6. ***S. japonicum*** Rothert in Fedtsch. Fl. As. Ross. 1 (1913) 26.— Ic.: (phot.) Rothert, l. c., tab. 2.

Perennial; stem erect, 50–80 cm long, stoutish; leaves 0.5–2 cm broad, thin, obtusely black-tipped; inflorescence containing (3) 4 or 5 (6) pistillate and 5–9 staminate heads; pistillate heads more or less approximate, the lower 1 or 2 (3) pedunculate; heads and peduncles axillary; styles 1–1.5 mm long, thick; stigmas broadly lanceolate, to 1.25 mm long; fruit borne on a stipe 2–5 mm long, fusiform, constricted at the middle, 4–5 mm long, gradually tapering toward apex. June–July. (Plate XI, Figure 6 a–c).

Banks of rivers and lakes, and marshes.— Far East: Uss. **Gen. distr.**: described from Japan, Nambu Province. Type in Leningrad.

Subgenus 2. **XANTHOSPARGANIUM** Holmb. in Bot. Notis, (1922) 206.
Perianth segments thin, pale-colored or colorless.

Cycle *Friesiana* Juz. nov.—Rather big plants; leaves not sharply keeled; inflorescence often branched; staminate heads relatively numerous or few; pistillate heads scattered; beak of fruit hooked from base; stigma rather short.—Among the American species, *S. fluctuans* (Morong) B. L. Robins apparently belongs to this cycle.

7. *S. Friesii* Beurl. in Bot. Not. (1854) 136; Kryl., Fl. Zap. Sib. I, 98.—*S. natans* L. Fl. lapp. (1737), 271 (sed non Sp. pl.); Fries in Bot. Not. (1849) 13, 154; (1852) 18 p. p.—*S. gramineum* Georgi Bemerk. Reise Russ. Reich, I (1775) 232.—*S. longifolium* Meinsh. in Mel. biol. Ac. Sc. Petersb. XIII (1893) 391 p. p., non Turcz.—Ic.: Bot. Not., 1852, tab. 1, 1 A.; Fl. Dan. Suppl. 170.—Exs.: HFR, No. 342, 2672; Pl. Finl., No. 20.

Perennial; stem floating, very long (ca. 1 m); leaves to 200 cm long, 1–3 mm broad, planoconvex or semiterete in upper part; inflorescence strongly elongate, often with 1 or 2 branches at base, the branches with 1 or 2 pistillate and 2 or 3 staminate heads, the primary axis bearing (2) 3–5 pistillate and 2–6 staminate heads; heads remote, axillary, sessile or the lowest pistillate head pedunculate, the peduncle sometimes very long; lower bracts very long, the uppermost short, scalelike; filaments and anthers very short, the latter 0.5–0.75 mm long; stigma 0.5–0.75 mm long, broad; fruit dark gray or dark brown, oblong, not constricted at the middle, borne on a fairly long stipe, abruptly beaked, the beak shorter than the body. July–August. (Plate X, Figure 7 a–b).

Lakes and sometimes rivers.—European part: Kar.-Lap., Lad.-Ilm., U. V.; E. Siberia: Dau.; Far East: Kamch. **Gen. distr.**: Scand. Described from Sweden, Bohuslän, Strömstad. Type in Stockholm.

Note. The specimens of *S. Friesii* so far known from Kamchatka are striking in having only 1 or 2 staminate heads; more material is needed, 223 however, to ascertain whether this character is in fact consistent for the Kamchatka plants.

Hybrid: *S. Friesii* Beurl. \times *S. simplex* Huds. = *S. longifolium* Turcz. in Bull. Soc. nat. Mosc. (1838) 103; Fl. baic.-dahur. II, 2 (1856) 170; Ldb. Fl. Ross. IV, 4.—*S. speirocephalum* Neum., l. c., p. p.—? *S. lanceolatum* Georgi Bemerk. Reise Russ. Reich, I (1775) 233.—Kar.-Lap., Lad.-Ilm., U. V., Dau. (Angara, loc. of *S. longifolium* Turcz.); erroneously reported for Sakh.

Cycle *Simplicia* Juz. nov.—Medium to big plants; leaves in lower part 3-angled, but not sharply keeled; inflorescence unbranched; pistillate heads more or less remote; beak of fruit straight; stigma 5–6 times as long as broad.

8. *S. simplex* Huds. Fl. angl. ed. 2 (1778) 401; Ldb. Fl. Ross. IV, 4, pro maxima parte; Kryl., Fl. Zap. Sib. I, 99.—*S. erectum* L. Sp. pl. (1753) 971 p. p.—*S. simile* Meinsh. in Mel. biol. Ac. Sc. Petersb. XIII (1893) 390 saltem p. p.—Ic.: Fl. Dan. 932; Sv. Bot. 342.—Exs. HFR, No. 340; Pl. Finl. 18 a, b; Woron. et Schelk. H. Fl. Cauc., No. 102.

Perennial; stem commonly erect, rarely floating, 30–50 cm long; leaves 7–10 mm broad, applanately triquetrous, sharply angled, the midrib (in dry material) often flexuous; inflorescence elongated, with 3–5 pistillate and 4–6 (–9) staminate heads; pistillate heads extra-axillary, the lower

pedunculate, the upper sessile, remote; staminate heads scattered on the elongated staminate part of the inflorescence axis; bracts slightly narrowed and narrowly scarious-margined at base; stamens long; anther linear to narrowly elliptic, 1.25—2 mm long; style long; stigma narrowly linear, 1.5—2.5 mm long; fruit brown or green, fusiform, constricted at the middle, long-stipitate, gradually tapering toward apex; style with stigma as long as or longer than the fruit excluding the stipe. June—July. (Plate XI, Figure 8 a—f).

Shores of lakes, rivers, brooks, backwaters, and canals, swamps, and similar places; occasionally penetrating into deeper water where it produces submerged forms with floating leaves.—European part: all, except the Arctic region and Crimea; Caucasus: Cisc., Dag., E. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Kamch., Ze.-Bu., Uss., Sakh.; Centr. Asia: Balkh., T. Sh. **Gen. distr.**: Eur. except the extreme S., Hither Asia, Manchuria, N. Am. Described from England (Norwich).

Note. The aquatic form, with floating planoconvex or flat leaves and often an elongate staminate inflorescence axis, is known under the name *S. longissimum* (Fries pro var. *S. simplicis*) Fritsch *Exkursionsfl.*, ed. 3 (1922), 643 in clavi; apparently, here should also be referred *S. emersum* Rehm. in *Verh. naturw. Ver. Brünn* (1871), 80 (1872). This form was published in HFR No. 2669 and is known in the USSR from Kar.-Lap., Dv.-Pech., Lad.-Ilm., U. V., V. Dnp. According to Asch. and Gr., it shows some degree of constancy.

9. **S. affine** Schnizl. *Typhac.* (1845) 27.—*S. natans* auct. mult. (p. p.).—*S. vaginatum* Larss. *Fl. Werml. and Dal.* (1859) 259.—*S. Borderi* Focke in *Abh. naturw. Ver. Bremen V* (1859) 409.— *Ic.*: Schnizl., l. c., fig. 44; *Fl. Dan. Suppl.* 171.— *Exs.*: HFR, No. 136.

Perennial; stem floating or rarely erect (terrestrial form—*S. Borderi* Focke); leaves 1—7 mm broad, semiterete to almost flat, the thin midrib not flexuous; inflorescence rather short, with (1) 2 or 3 (4) pistillate and 2—4 staminate heads; pistillate heads extra-axillary, pedunculate, rarely sessile, approximate to subremote; staminate heads closely approximate, in anthesis confluent; staminate part of inflorescence short; leaves broad and scarious-margined at base; anthers broadly elliptic, ca. 1 mm long; style rather short; stigma lance-subulate, 0.75—1.25 mm long; fruit yellow or brown, fusiform, constricted at the middle, long-stipitate, gradually tapering toward apex; style together with stigma usually shorter than the fruit. June—August. (Plate XI, Figure 9 a—c).

Mostly in lakes and lakelets (the floating form), rarely on their shores (the terrestrial form). European part: Kar.-Lap., Lad.-Ilm., Dv.-Pech., U. V.; Far East: Kamch. (?). **Gen. distr.**: Europe, except the S. parts. Described from Darensee, Koenigshuld.

Note. The Kamchatkan location of *S. affine* is completely disjunct from the main distribution area of this species, apparently gravitating toward the area of the North American *S. angustifolium* Michx. which is closely related to *S. affine*. Availability of sufficient material will probably make it possible to set up the Kamchatka plant as a distinct race.

Hybrids: *S. affine* Schnizl. × *S. Friesii* Beurl. (*S. speirocephalum* Neum. ap. Krok, Hartm. *Handb. Sk. Fl.* (1889) 109 pro max. p.; Kar.-Lap., Lad.-Ilm. (Leningrad area, Yukki, Bologoe).

S. affine Schnizl. \times *S. glomeratum* Laest. There are dubious reports for Kamchatka.

S. affine Schnizl. \times *S. simplex* Huds. (*S. splendens* Meinsh. in Mel. biol. Ac. Sc. Petersb. XIV (1893) 388); Kar. -Lap. (N. part of Lake Onega, etc.), Lad. -Ilm. (Leningrad Region, Taitsy — thence described *S. splendens* Meinsh.).

Cycle Glomerata Juz. nov. — Mostly plants of medium size; leaves sharp-keeled; inflorescence unbranched; staminate heads 1 to few; pistillate heads more or less crowded; beak of fruit straight; stigma short.

10. ***S. glomeratum*** Laest. ap. Beurl. Oefvers. Vet. Ak. Förh. IX (1853) 192; Kryl., Fl. Zap. Sib. 98. — *S. fluitans* Fries Summa Veget. II (1849) 559. — Ic.: Bot. Not. 1852, tab. 1, 3. Fl. Dan. Suppl., 169. — Exs.: Pl. Finl., No. 19; HFR, No. 341, 2668.

- 225 Perennial; stem always erect; leaves exceeding the stem, 8–12 mm broad, with a winged keel beneath; inflorescence with (2) 3–5 (6) pistillate and usually 1 or rarely 2 staminate heads; pistillate heads very closely approximate on the inflorescence axis, commonly sessile, upward tightly crowded into a single group, rarely the lowest (or the lowest 2) stipitate and then often axillary, remote from the rest; staminate head usually contiguous with the uppermost pistillate head; stamens short; anthers very small, 0.5–0.75 mm long; style short; stigma 0.5–0.75 mm long, subulate-lanceolate; fruit constricted at the middle, stipitate, the lower part broader, the upper part tapering into the style. July–August. (Plate XI, Figure 10).

Swamps, swampy woods, brooks, canals, and ditches. European part: Kar. -Lap., Dv. -Pech., Lad. -Ilm., U. V., U. Dnp., V. -Don; W. Siberia: Ob; E. Siberia: Yen., Lena-Kol., Dau.; Far East: Kamch., Uss. **Gen. distr.**: Scand. Described from Sweden.

Hybrids: *S. glomeratum* Laest. \times *S. simplex* Huds.; Kar. -Lap., Kamch.

11. ***S. Glehnii*** Meinsh. in Mel. biol. Ac. Petersb., t. XIII, livr. 3 (1893) 390.

Perennial; differing from *S. glomeratum* in the less crowded pistillate heads, of which the lowest even more remote; staminate heads more numerous, more distant from the pistillate. — Far East: Sakh. (forms of *S. glomeratum* approaching *S. Glehnii* in some of the characters, also occur in Uss.). **Gen. distr.**: Japan? Described from Sakhalin, from Tunai village. Type in Leningrad.

Note. A very critical species; more ample material from Sakhalin is needed to confirm its independent standing.

Cycle Minima Asch. et Gr. Syn. I (1897) 291. — Small plants; leaves flat; inflorescence unbranched; staminate heads 1 (2); stigma ovoid or often globose, not more than twice as long as broad, often sessile.

12. ***S. minimum*** Hill Brit. Herb. (1756) 507; Fries in Bot. Not. (1849) 154 et Summa veget. II (1849) 560; Kryl., Fl. Zap. Sib. I, 100. — *S. natans* Ldb. Fl. Ross. IV, 5 pro parte et auct. mult. — *S. ratis* Meinsh. in Bull.

Soc. Nat. Moscou N. S. III (1889) 174. — *S. septentrionale* Meinsh., l. c. — *S. flaccidum* Meinsh. in Mel. biol. Ac. St. Petersburg. XIII (1893) 393. — *S. perpusillum* Meinsh., l. c. (1893) 394. — Ic.: Fl. Dan. 260; Bot. Not. 1852, tab. 1, 2. Exs.: HFR, No. 532, 692, 2670, 2671; Fl. Finnl., No. 21; Wor. et Schelk. H. Fl. Cauc., No. 101.

Perennial; stem floating, rarely erect, 8–30 cm long, with a large number of internodes (4–9, commonly 5–7); leaves shorter than the stem, 1.5–10 mm broad (commonly 3–5 mm), mostly thin, the midrib not prominent; inflorescence with (1) 2 or 3 (4) pistillate and 1 or rarely 2 staminate heads; pistillate heads all sessile or the lowest short-peduncled, axillary, regularly disposed; staminate heads separated from upper pistillate head by a distinct
226 internode; stamens relatively long; anthers ovaloid, 0.75 mm long; style short, but quite distinct; stigma ovoid to lanceolate, to 0.75 mm long; fruit broadly fusiform to ovoid, constricted at the middle, with narrower lower part, rather dull, borne on a stipe to 1 mm long. July–August. (Plate XI, Figure 11 a–c).

Lakelets, ponds, canals, and swamps. — European part: Kar. -Lap., Dv. -Pech., Lad. -Ilm., U. V., V. -Kama, U. Dnp., M. Dnp., V. -Don, Transv., L. Don; Caucasus: E. Transc. (Akhalkalaki District and Bakuriani in Borzhomi District); W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Ang. -Say., Dau.; Far East: Kamch. Gen. distr.: W. Eur., excluding Med.; N. Am. Described from England.

Note. In addition to *S. minimum*, Meinshausen distinguished in the Leningrad area four related "species" (see synonymy), which apparently represent merely ecological forms of purely local importance. Thus, his *S. ratis* gives rise to characteristic floating islets on forest lakes of the Karelian Isthmus (Konnaya Lakhta); *S. septentrionale* is a form of boggy woodland meadows of the same district (Levashevo); *S. flaccidum* is a large broadleaved form of waters with a high content of organic matter (Kolomyagi); *S. perpusillum* is associated with the marshy coast of the Gulf of Finland (Lakhta; published in HFR, No. 692, under the dubious name *S. minimum* v. *ratis* Meinsh.).

Hybrids: *S. minimum* Hill × *S. simplex* Huds. (*S. oligocarpum* Angstr. Bot. Not. (1855) 149 p.p.; *S. diversifolium* Graebn. in Schrift. naturf. Ges. Danz. N. F. IX (1895) 335); Kar. -Lap., U. V., also reported for Alt. and Lena-Kol. — The critical *S. Wirtgeniorum*, reported for Bessarabia, represents an intermediate form between *S. minimum* and *S. simplex* (Asch. et Gr. p. var. *S. diversifolii*) Rouy Fl. France XIII (1912) 339).

13. *S. hyperboreum* Laest. ap. Beurl. Ofvers. Vet. Ak. Förh. 1852 (1853) 192. — *S. natans* Ldb. Fl. Ross. IV, 5 pro parte. — *S. submuticum* Neum. in Hartm. Scand. Fl. 12 uppl. (1889) 108. — *S. angustifolium* Meinsh. in Mel. biol. Ac. St. Petersburg. XIII (1893) 396, non Michx. — Ic.: Fl. Dan. 2792.
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Perennial; stem with few (not more than 5) internodes; leaves overtopping the stem, very narrow (commonly 1–2 mm, rarely up to 7 mm broad), thickish to thick; inflorescence with extra-axillary irregularly disposed pistillate heads, of these the lower mostly long-peduncled, the upper often crowded; staminate head tightly contiguous with upper pistillate head; style very short and barely perceptible or none; stigma subglobose,



Plate XI

1. *Sparganium polyedrum* A. et Gr.: a) leaf in cross section; b) pistil; c) fruit; d) fruiting scale; e) fruiting head; f) fruit in longitudinal section; g) seed.— 2. *S. stoloniferum* Buch.-Ham.: a) fruiting scale; b) fruit.— 3. *S. neglectum* Beeby: a) leaf tip; b) portion of inflorescence with fruiting heads; c) fruiting scale; d) fruit; e) same in longitudinal section; f) seed.— 4. *S. microcarpum* Čelak.: a) fruiting scale; b) fruit; c) same in longitudinal section.— 5. *S. stenophyllum* Max.: a) leaf tip; b) portion of inflorescence; c) pistil.— 6. *S. japonicum* Rothert: a) fruiting head; b) fruiting scale; c) fruit.— 7. *S. Friesii* Beurl.: a) fruiting portion of inflorescence; b) fruit.— 8. *S. simplex* Huds.: a) leaf in cross section; b) stamen; c) pistil; d) scale; e) portion of inflorescence with fruiting head; f) fruit.— 9. *S. affine* Schnizl.: a) stamen; b) pistil; c) fruit.— 10. *S. glomeratum* Laest.: fruiting inflorescence.— 11. *S. minimum* Hill: a) leaf; b) fruiting inflorescence; c) fruit.— 12. *S. hyperboreum* Laest.: fruit.

rarely lanceolate and then not more than 3 times as long as broad; stamens short; anthers 7.3—7.5 mm long, subglobose; fruit typically minute (ca.2 mm long), broadly ovoid, obtuse at summit, brownish yellow, dull, short-stipitate, obscurely beaked. August. (Plate XI, Figure 12).

Lakelets and other water bodies, among marshes and tundras (sometimes in brackish water).— European part: Arc. Eur., Kar. -Lap., Dv. -Pech.; E. Siberia: Lena-Kol., Ang. -Say., Dau.; Far East: Kamch. **Gen. distr.:** Scand., Centr. Eur., Iceland, Arc. and subarctic zone. N. Am. Described from Sweden, Torne Lapmark, Manu.

Hybrid: *S. hyperborea* Laest. × *S. minimum* Hill. So far not authenticated in the USSR. Rothert in herb. assumed a number of samples from Okh. and Uss. to represent this hybrid; however, these samples apparently belong to a distinct species which indeed occupies an intermediate position between these two but is rather constant in its characters. It may be identical with the North American *S. Williamsii* Rydb. Neither *S. hyperborea* nor *S. minimum* have been found in Okh. or Uss.

Order 2. **Helobiae** RCHB.

Flowers cyclic or semicyclic, ranging from achlamydeous to choriphyllous, with superior or inferior ovary; stamens and carpel 1 to many, distinct or connate; microspores 3-nucleate; endosperm obsolete or obsolescent. Aquatic or paludic plants with axillary stipules.

Family XVII. **POTAMOGETONACEAE** ENGL.*

Flowers bisexual or unisexual (monoecious), in a spikelike inflorescence borne on a cylindric axis and not inclosed in the sheath of the terminal leaf, or rarely flowers solitary in the leaf axils; perianth none though sometimes the flowers surrounded by a scarious spathe; stamens 1—4; anthers 1- or 2-locular, the connective often petaloid; pollen grains globose or curved; pistils 1—4; stigma 1; ovule 1; fruit a nutlet or drupelet; seeds with a curved embryo, without endosperm.

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- 1. Flowers in a spikelike inflorescence (this sometimes consisting of but 2 flowers), bisexual, without perianth (*Potamogetoneae* Rchb.) 2.
- + Flowers solitary or paired in the leaf axils, monoecious; at least the pistillate flowers covered by a scarious spathe (*Zannichellieae* Kunth.) 52. **Zannichellia** L.
- 2. Spike cylindric or subspherical, mostly many-flowered; stamens 4, the connectives with large sepal-like outgrowths; fruit sessile 3.
- + Spike 2-flowered; stamens 2, with short connective outgrowths; fruit raised on a stalk, this several times the length of the fruit 51. **Ruppia** L.
- 3. Leaves alternate, with axillary stipules (ligules), these sometimes united into a sheath with the lower part of the leaf; outgrowths of filaments petaloid, rounded, obtuse 49. **Potamogeton** L.

* Arranged by S. V. Yuzepchuk.

- + Leaves opposite or sometimes in whorls of 3, exstipulate; outgrowths of filaments triangular, pointed at apex. 50. *Groenlandia* J. Gay.

Tribe 1. **Potamogetoneae** RCHB.

Rchnb. Consp. (1829) 43.

Flowers bisexual, in a spikelike inflorescence; stigma small, sessile or nearly so, papillose.

Genus 48. **POTAMOGETON** * L.

L. Gen. pl. ed. 1 (1737) 33; Sp. pl., ed. 1 (1753) 126.

Flowers rather numerous, in a cylindrical terminal inflorescence borne on an erect peduncle; perianth none; stamens 4, the connective furnished with a rounded winglike petaloid outgrowth; anthers oblong; pollen grains globose; pistils 4, sessile; ovule 1, campylotropous; fruit nutlike, with a thick exocarp, indehiscent; embryo falcate or spirally coiled through one turn. Aquatic or more rarely paludic herbs, with a creeping rhizome and simple or branched stem; leaves alternate, variously shaped, sheathing or with an entire axillary stipule. Tips of branches often enlarged and forming winter buds which serve as organs of vegetative propagation.

231 The aquatic habit was conducive to fossilization of some pondweeds, particularly in interglacial Quaternary or more rarely Tertiary formations. Most ancient of these is *Potamogeton uralense* Krysh. — in Tertiary formations (Eocene or even upper Cretaceous period?), Ob (Lozva R.). Other species found: *P. alpinus* Balb. — in Quaternary formations of Dv.-Pech. (Vologda); *P. crispus* L. — in the Pliocene of S. Transc. (Oltu area) and in Quaternary formations of U. V. (Likhvin); *P. heterophyllus* Schreb. — in Quaternary formations of U. V. (Likhvin); *P. natans* L. — in the Pliocene of S. Transc. (Oltu area) and in Quaternary formations of L. Don (Archeda), U. Dnp. (Smolensk area, Minsk), U. V. (Likhvin), V.-Kama (Kostroma area — Galich); *P. acutifolius* Link. — in U. V. (Likhvin), V.-Kama (Galich); *P. pectinatus* L. — in Quaternary layers of Dv.-Pech. (Vologda); *P. polygonifolius* Pour. — in Quaternary formations of V.-Kama (Galich); *P. praelongus* Wulf. — in Quaternary formations of Dv.-Pech. (Vologda); *P. pusillus* L. — in Quaternary formations of Dv.-Pech. (Vologda); *P. trichoides* Cham. — in Quaternary formations of V.-Kama (Galich). Remnants of *Potamogeton* of undetermined species have also been reported from U. Dnp., U. V. (former Bezhetzsk County), Dv.-Pech. (Vologda), and Ob (Demyanskoe).

Economic importance. Pondweed species are of importance for the fish industry, chiefly on account of the small animals and their larvae that live on their underground parts and serve as food for fish. Various kinds of fish spawn among pondweed thickets and the fry find refuge there. Pondweeds tend to overgrow water bodies; the thick growth of some species may impede the movement of ships and boats and may interfere with swimming, etc. The plants brought out in the course of clearing operations are useful as manure on account of lime deposited on the leaves and the nitrogen content of the animal organisms. The tubers formed on the rootstocks of some of the species are edible. See also notes in connection with individual species.

Note. Of the large number of hybrids known between various species of this genus, only relatively few have so far been reliably identified in the flora of the USSR. They all display some degree of sterility (defective pollen or abortive fruits) but they often succeed in covering extensive areas

* From Greek *potamos*, river, and *geiton*, neighbor.

by means of vegetative reproduction. The most widespread hybrids are erroneously reported in many "Floras" as independent species (*P. Zizii* Mert. et Koch., *P. sparganiifolius* Laest., *P. nitens* Web.). Pondweed hybrids represent various combinations of parental characters, hence their inclusion in the key would present difficulties.

1. All leaves narrowly linear, entire, the well developed sheath stipular at apex; whorls of the inflorescence remote (Subgenus *Coleogeton* Raunk.) 2.
- + Leaves variously shaped, not sheathing, with stipule in the leaf axil, very rarely with a short sheath and then the leaves broadly linear, with serrulate to denticulate margin; inflorescence rather dense, only the lower whorls subremote (Subgenus *Eupotamogeton* Raunk.) 8.
- 232 2. Leaves brittle; sheaths brown-marginate, their margins connate below (Section *Connati* Hagstr.) 3.
- + Leaves firmer, not brittle; sheaths commonly white-marginate, splitting all the way down, convolute (Section *Convoluti* Hagstr.) 5.
3. Stem simple above; leaves acutish or obtuse; fruit with a very short wartlike beak 4.
- + Stem much branched; leaves round-tipped; fruit with a pointed slightly recurving beak 3. *P. amblyophyllus* C. A. M.
4. Leaves very narrow, filiform, 1-nerved, pointed 1. *P. filiformis* Pers.
- + Leaves 1—3 mm broad, 3—5-nerved, obtuse 2. *P. pamiricus* Baagoe.
5. At least some of the leaves retuse 4. *P. subretusus* Haagstr.
- + Leaves acuminate, rarely obtuse, but not retuse 6.
6. Leaf sheaths very strongly developed, broad, investing 3 or 4 or rarely but 2 branches; fruit with a short wartlike beak. 5. *P. vaginatus* Turcz.
- + Leaf sheaths narrow or rarely broad, usually investing 2 branches; fruit with a rather elongate slightly recurving beak 7.
7. Leaves commonly not more than 1 mm broad, 1—3-nerved; fruit not keeled on the back 6. *P. pectinatus* L.
- + Leaves to 3 cm broad, 3—7-nerved; fruit keeled on the back 6-a. *P. interruptus* Kit.
8. Leaves all submersed, linear, short-sheathing at base, ligulate-tipped, the margin denticulate (Section *Adnati* Hagstr.) 7. *P. Maackianus* A. Benn.
- + Leaves not sheathing at base 9.
9. Stem compressed 4-angled; all leaves submersed, their margin sharply serrulate; fruit with a beak the length of the body, the fruits united at base (Section *Batrachoseris*-Irmsch.) 8. *P. crispus* L.
- + Stem terete or compressed, but not 4-angled; submersed leaves entire or slightly denticulate; fruits with shorter beak, not united at base. 10.
10. All leaves submersed, linear or narrowly linear; only very exceptionally the upper ones spatulately enlarged at the tips, the broad part 3-nerved (Section *Chloeophylli* Koch) 11.

- 233 + Leaves partly submersed and partly floating, the latter at least 5-nerved; or all leaves submersed, not linear, fairly broad. 24.
11. Stem rather strongly compressed; leaves many-nerved 12.
- + Stem usually slightly compressed or terete; leaves (1) 3–5 (–7) nerved 18.
12. Stem about as broad as the leaves, rarely but half as broad, 2–3 mm in diameter 13.
- + Stem slender, at most half as broad as the leaves, commonly not more than 1 mm in diameter 15.
13. Leaves short-apiculate from a rounded apex; peduncle 2–4 times the length of inflorescence 14.
- + Leaves long-acuminate; peduncle about as long as inflorescence; fruit ca. 3 mm long, the beak representing an extension of the ventral side 11. *P. acutifolius* Link.
14. Stem stout, 2–3 mm in diameter; fruit ca. 2 mm long, the beak central 9. *P. zosterifolius* Schum.
- + Stem half as thick as in the preceding species; fruit as in *P. acutifolius* Link. (see preceding stage) 10. *P. Henningii* A. Benn.
15. Leaves with margins nearly parallel throughout, abruptly attenuate at apex, symmetric, straight 16.
- + Leaves gradually attenuate from broader base, curved toward the usually asymmetric apex 15. *P. oxyphyllus* Miq.
16. Stem very slender, commonly less than 1 mm in diameter; stipules brown; inflorescence 6–8-flowered 13. *P. subsibiricus* Hagstr.
- + Stem somewhat stouter, ca. 1 mm in diameter; stipules pale; inflorescence many-flowered 17.
17. Lateral veins of leaves distinct, progressively thinner toward the margin; peduncles slightly enlarged toward apex; fruit tuberculate on ventral side; 3-keeled on the back, the lateral nerves more prominent than the medial 12. *P. sibiricus* A. Benn.
- + Lateral veins of leaves very thin and often obscure; peduncles uniformly thick throughout; fruit with 2 dentiform basal tubercles on the ventral margin, the dorsal margin with a prominent sharp keel and fainter lateral keels 14. *P. manchuriensis* A. Benn.
18. Leaves very narrow, setaceous, dark green, with a very thick midrib and 2 pellucid lateral veins, long-acuminate; fruit rather large, 2–3 mm long 16. *P. trichoides* Cham. et Schlecht.
- 234 + Leaves narrow to rather broad, green or pale green, with 3–5 (–7) pellucid veins; fruit usually not more than 2 mm long 19.
19. Leaves terminating in a rather long mucro or often gradually acuminate, mostly stiff; stipules connate at base, ochreate 20.
- + Leaves obtuse, round-tipped or mucronulate, flaccid; stipules split to base, convolute 23.
20. Upper leaves (bracts) spatulately dilate at apex, subcoriaceous 20. *P. limosellifolius* Maxim.
- + All leaves commonly linear 21.
21. Leaves round-tipped, mucronate, 5-nerved 18. *P. Friesii* Rupr.
- + Leaves gradually long-acuminate, 3-nerved 22.
22. Stem compressed; leaves 4–6 cm long, very stiff, strict 17. *P. rutilus* Wolfg.

- + Stem terete; leaves 3—4 cm long, less stiff. 19. *P. panormitanus* Biv.
23. Leaves 2—3 mm broad, 3—5-nerved, the lateral veins usually faint; peduncles ca. 1 cm long. 21. *P. obtusifolius* M. K.
- + Leaves usually not more than 1 mm broad (rarely up to 1.5 mm), 3-nerved, the lateral veins rather distinct; peduncles to 3 cm long 22. *P. pusillus* L.
24. Leaves of two kinds, floating (coriaceous) and submersed, or else all leaves submersed, the latter linear, lanceolate or oblong, usually narrowed toward base, sessile or petioled (Section *Heterophylli* Koch.) 25.
- + All leaves submersed, elliptic, ovate, or elongate, rounded or cordate at base, sessile, amplexicaul (Section *Peltopsis* Rouy) 39.
25. Submersed leaves narrowly linear. 26.
- + Submersed leaves oblong or lanceolate 30.
26. Submersed leaves flat, thin, translucent, usually not more than 1 mm broad (Cycle *Javanici* Graebn.) 27.
- + Submersed leaves semiterete, firm, not translucent, petiolar, to 1 cm broad. 33. *P. natans* L.
27. Fruit with a smooth or toothed dorsal keel 28.
- + Fruit with a crested long-toothed keel 23. *P. cristatus* Rgl. et Maack.
- 235 28. Floating leaves oblong or lanceolate, gradually narrowed toward base and toward apex, acuminate, 7-nerved, the nerves shallowly concave beneath; embryo horseshoe-shaped 29.
- + Floating leaves linear-lanceolate, abruptly narrowed at base and at apex, obtusish, 5-nerved, the nerves strongly concave beneath; embryo spirally coiled 26. *P. miduhikimo* Mak.
29. Stem branching at an acute angle; submersed leaves flexible; fruit commonly toothed on the back 24. *P. javanicus* Hassk.
- + Stem branching at a nearly right angle; submersed leaves stiff; fruit with 3 small teeth merely at base 25. *P. asiaticus* A. Benn.
30. Submersed leaves entire 31.
- + Submersed leaves sparsely and often obscurely denticulate 35.
31. Submersed leaves sessile; floating leaves short-petioled (the petiole not longer than blade) or wanting; style elongated (Cycle *Alpini* Graebn.) 32.
- + Submersed leaves petiolate; floating leaves long-petioled, always present; style short (Cycle *Amplifolii* Hagstr.) 33.
32. The dorsal and the ventral margin of fruit about equally convex, gradually narrowed toward apex; style central, straight or slightly curved 27. *P. alpinus* Balb.
- + The ventral margin of fruit very slightly convex and prolonged into a short, recurving style; the dorsal margin very strongly convex 28. *P. tenuifolius* Raf.
33. Floating leaves 21—34-nerved, with a dense network of transversal veins 31. *P. Fryeri* A. Benn.
- + Floating leaves 13—17-nerved 34.
34. Floating leaves broad, 15—17-nerved, obtusish; stigma oblong-ovoid; fruit tuberculate at base 29. *P. Franchetii* A. Benn.
- + Floating leaves narrower, 13-nerved, more acute; style more rounded; fruit not tuberculate at base 30. *P. digynus* Wall.

- 236 35. Submersed leaves early decaying, dull, the margins with weak 1-celled denticles; floating leaves always present, very firm, long-petioled 32. **P. nodosus** Poir.
 + Submersed leaves persistent, lustrous, usually margined with well-developed denticles; floating leaves often wanting or rather thin and relatively short-petioled (Cycle Lucentes Graebn.) 36.
 36. Submersed leaves sessile or very short-petioled 37.
 + Submersed leaves (especially the upper ones) borne on very long petioles 38.
 37. Submersed leaves sessile, usually not more than 1 cm broad; floating leaves often wanting 34. **P. heterophyllus** Schreb.
 + Submersed leaves short-petioled, to 4.5 cm broad; floating leaves never present 35. **P. lucens** L.
 38. Floating leaves none 36. **P. malainus** Miq.
 + Floating leaves present 37. **P. distinctus** A. Benn.
 39. Stem straight; leaves deeply cordate at base, denticulate-margined, blunt at apex; stipules usually not more than 1 cm long, whitish, thin 39. **P. perfoliatus** L.
 + Stem slightly zigzag; leaves rounded at base, entire, hooded at apex; stipules 1.5–6 cm long, stramineous, stiff 38. **P. praelongus** Wulf.

Subgenus A. **COLEOGETON*** (Rchb.) Raunk. De Dansk. Blomsterpl. Naturhist. I, 1 (1896) 103. All leaves alike, submersed, narrowly linear, more or less channeled, always distinctly sheathing, the sheath surmounted by a stipule; peduncles commonly flexuous; inflorescence after anthesis with more or less remote whorls; pollination under water.

Section 1. **CONNATI** Hagstr. Crit. res. Pot. in Kgl. Sv. Vetenskap. Handl. 5, No. 5 (1916) 13. Leaves brittle, mostly 3-nerved, the lateral nerves running along the margins; sheaths brown-margined, those of young sheaths closed below by the united margins; pollination under water.

Cycle 1. **Filiformes** Hagstr., l. c., 14. Fruit with a very short wartlike beak.

1. **P. filiformis** Pers. Syn. I (1805) 152; Kryl., Fl. Zap. Sib., 114.—**P. marinus** auct. mult. non L.; Ldb. Fl. Ross. IV, 31.—**P. fasciculatus** Wulfg. in Roem. et Schult. Mant. III (1827) 364.—Ic.: Rchb. Ic. Fl. Germ. VII (1845), tab. 18, fig. 28, 29; Fryer et Bennett, Potam. Brit. Isl. pl. 60.—Exs.: Pl. Finl., No. 28, 434; H. Fl. As. Med., No. 408 a, b.

Perennial; rhizome slender, creeping; stem to 30 cm long, slender, filiform, terete or somewhat compressed, slightly branched at base, simple above; leaves 5–10 cm long, narrowly filiform, 1-nerved, rather pointed; sheaths 5–15 mm long, investing but one branch; stipule to 7 mm long; peduncle (1-) 2–7 cm long, filiform; inflorescence 3–7 (–9) cm long, many-flowered, the flowers in 3–4 (–5) very remote whorls; outgrowths of

* From Greek koleso, vagina, and geton, neighbor.

connectives obovate; pistil with a short style and a horizontal stigma;
237 fruit small, 2×1.5 mm, obliquely ovoid, olivaceous, slightly compressed laterally, rounded and obscurely 3-ridged on the back, the beak nearly central. June—August. (Plate XII, Figure 3, a—c).

Lakes, brooks, and sometimes brackish water.— European part: Lad.-Ilm., U. V.; Caucasus: Cisc., E. Transc., Tal.; E. Siberia: Yen. (?), Ang.-Say. (Lake Manskoe); Far East: Kamch., Uda; Centr. Asia: Ar.-Casp., Kyz. K., Kara K., Syr D. **Gen. distr.**: N. and Centr. Eur., N. Am., Asia, Afr., and Austr. Described from Denmark.

Note. The Central Asian forms are distinguished by their rather large fruits and they need critical study.

Hybrid: *P. filiformis* Pers. × *P. pectinatus* L. (= *P. suecicus* Richt., Pl. Eur. I (1890) 15, nomen).— Baagoe referred a specimen from the Uda area (Ayan) to this hybrid.

2. ***P. pamiricus*** Baagoe in Vidensk. Medd. Naturh. Foren. (1903) 182.

Perennial; stem more than 1 m long, terete, simple or nearly so, with internodes (2—) 8—12 cm long, covered in lower part with leafless sheaths; leaves to 12—20 cm long, narrowly linear, 1—3 mm broad, 3—5-nerved, obtuse; sheaths 2—3 cm long, 4—7 mm broad, green, scarious-margined toward base, stiff, slightly inflated, unbranched at the axils; stipules of upper leaves somewhat less than half the length of the sheath, obtuse; peduncle 3—4 cm long, rather rigid, strict, apparently lateral; inflorescence few-flowered, the whorls separated by short internodes; fruit small, obliquely ovoid, with an obliquely ovoid stigma. June—July.

Mountain lakes.— Centr. Asia: Pam. **Gen. distr.**: Endemic. Described from Lake Kara-Kul' in the Pamir.

Cycle 2. *Amblyophylli* Hagstr. Crit. Res. Potam., etc. 29.

Fruit with a pointed slightly recurving beak.

3. ***P. amblyophyllus*** C. A. M. in Beitr. zur Pflanzenkunde der russ. Reiches (1849) 10.— Ic.: Hagstr. Crit. Res. Pot. 29, fig. 9.

Perennial; stem 20—30 cm long, much branched, with very short internodes and equidistant whorls; leaves 5—6 cm long, ca. 1 mm broad, 3-nerved (the lateral nerves marginal), rounded-obtuse; sheaths ca. 1.5 cm long, brownish, investing only 1 branch; stipules 8—10 mm long, somewhat retuse; peduncles 5—7 cm long, filiform; inflorescence ca. 2 cm long, of 5 or 6 whorls, of which the lowest subremote, the others approximate; fruit 3.5×2 mm, with convex sides, the rounded back without a keel, the well-developed beak distinctly incurved.

238 Mountain streams. Caucasus: Cisc.; reports for Alt. and Centr. Asia need confirmation. **Gen. distr.**: N. China? (according to Hagström). Described from Kazbek. Type in Leningrad.

Section 2. **CONVOLUTI** Hagstr., l. c., 30. Leaves firmer, 3—5 (—7)-nerved; sheaths often white-marginate, always split below, in lower part convolute. Pollination on the water surface.

Cycle 1. *Vaginati* Hagstr., l. c., 30. Fruit with a short wartlike beak.

4. ***P. subretusus*** Hagstr. in Kgl. Sv. Vetenskaps. Handl. Bd. 55, No. 5, (1916) 30.— Ic.: Hagstr., l. c., fig. 10.

Perennial; rhizome slender; stem long, filiform, very slender, terete, branched, the lower internodes short, the upper elongate; leaves to 10 cm long, narrowly linear, thin, almost flat, 3 (5)-nerved, obtuse and often (especially the bract-leaves retuse; sheaths 2–3 (–4) cm long, split, brownish-margined; stipules thin, 7–10 mm long; peduncle 10–15 cm long, very slender, flexuous; inflorescence ca. 3.5 cm long, of 6–7 (–8) equidistant whorls, the internodes short; style obsolescent; stigma rounded, persistent and in fruit wart-shaped; fruit 2.5 × 1.5 mm, obliquely obovoid, with flat or somewhat convex sides, 2-grooved on the back; stigma curved toward the ventral margin.

Arc.; E. Siberia: Yen. **Gen. distr.**: Endemic. Described from the Yenisei River (Nikandrovskii and Malo-Brekhovskii Islands, 70°50' N. lat.).

5. ***P. vaginatus*** Turcz. in Bull. Soc. Nat. Mosc. (1854) 66.— Ic.: Hagstr. cirt. res. Potam. fig. 11.— Exs. Pl. Finl., No. 26, a, b; HFR, 1935.

Perennial; rhizome stout; stem very long, stout, terete, much branched, with rather long internodes; leaves short, 1–7 cm long, linear to narrowly linear, flat, commonly 3-nerved, acuminate; sheaths 3–7 cm long, strong, open, brownish-margined, investing (2) 3 (4) branches; stipule stiffish; short; peduncle 3–6 (–20) cm long, slender and flexuous; inflorescence 2, 5–6 (–10) cm long, of ca. 8 equidistant whorls; style short, with a horizontal stigma; fruit medium size, 2–3 mm long, rounded on the back and on the sides, with a short wartlike beak. July–August.

Lakes.— E. Siberia: Ang.-Say., Dau. **Gen. distr.**: Scand., N. Mong. Described from Dauria (Selenga salt lakes). Type (or cotype) in Leningrad.

Cycle 2. *Pectinati* Hagstr. Crit. Res. Pot. 39. Fruit with a more or less elongated slightly recurving beak.

239 6. ***P. pectinatus*** L. Sp. pl. (1753) 127; Ldb. Fl. Ross. IV, 30 (synon. excl.); Kryl., Fl. Zap. Sib. 1, 113.— Ic.: Rchb. Ic. fl. germ. VII, t. XIX, fig. 30; Freyr et Bennett Pot. Brit. Isl., pl. 57.— Exs.: Pl. Finl., No. 27.

Perennial; rhizome long, creeping, much branched, profusely tuberiferous in fall; stem to 50–100 cm (or more) long, slender, simple below and branched in upper part or else branched from base, the internodes 1.5–5 (–10) cm long; leaves 5–15 cm long, the lower ca. 1 mm broad, 3-nerved, the upper setaceous, 1-nerved, point-tipped or acute; sheaths 2–5 cm long, open, light-margined, commonly investing 2 branches; stipule to 1 cm long, obtuse, whitish; peduncle 5–10 cm long, filiform, of same thickness throughout; inflorescence 3–6 cm long, few-flowered, interrupted, commonly of 5 whorls; fruit large, 3.5–4.5 × 3 mm, plump, obliquely ovoid, the flat or slightly convex ventral margin prolonged into a very short beak, the dorsal margin without a keel. July–August. (Plate XII, Figure 4 a–e).

Lakes, rivers, and other water bodies.— The whole of European part, except the Arctic region; Caucasus: Cisc., Dag., W. Transc., E. Transc.,

S. Transc., Tal.; W. Siberia: Ob, U. Tob., Irt.; E. Siberia: Yen., Ang.-Say., Dau., Lena-Kol.; Far East: Kamch., Uss.; Centr. Asia: Ar.-Casp., Balkh., T. Sh., Kara K., Syr. D. **Gen. distr.**: all parts of the world. Described from Europe. Type in London.

Economic importance. Used as manure. The tubers may be used as feed for pigs.

Note. An extremely polymorphic and undoubtedly composite species. One of the forms is represented in the USSR by *P. interruptus* Kit. ap. Schultz Oest. Fl. ed. 2 (1814) 328. (*P. flabellatus* Bab. Man. Brit. Bot. ed. 3 (1851) 343), distinguishable by the broader (to 2.5 mm) 5–7-nerved leaves and the fruit with dorsal keel and 2 prominent lateral ribs. (Dv.-Pech., Lad.-Ilm., U. V., V.-Don, Bl., L. V., Crim., Ob, Alt., Yen.).

Hybrid: *P. pectinatus* L. × *P. vaginatus* Turcz. (= *P. bottnicus* Hagstr. Crit. res. on the Pot. (1916) 52). Kar.-Lap.

Subgenus B. **EUPOTAMOGETON*** RAUNK. De Dansk. Blomsterpl. Naturkist, I, 1 (1896) 34, 108. Leaves all alike, submersed, narrow, linear, lanceolate, oblong, or ovate, flat or undulate, or else of two or three kinds: submersed, as described above or sometimes reduced to midrib, and floating subcoriaceous leaves; all leaves commonly without sheaths, rarely short-sheathing, always with axillary stipules; peduncle not flexuous; inflorescence after anthesis dense or with scarcely distant whorls. Pollination by wind.

Section 3. **ADNATI** Hagstr. Crit. Res. Potam. (l. c.) 53. Stems compressed, 2-channeled; leaves all alike, flat, dentate on the margin, with a very short sheath at base.

Cycle 1. *Serrulati* Hagstr., l. c. Characters of the section.

7. **P. Maackianus** A. Benn. in Journ. of Bot. XLII (1904) 74.—*P. serrulatus* Rgl. et Maack in Rgl. Tent. Fl. Ussur. (1861) 153, non Schrad., non Opiz.—Ic.: Graebn. in Engl. Das Pflanzenr. IV, 11 (1907) 108, fig. 26.

Perennial; stem rather robust, branched, to 15 cm long, with internodes ca. 2 cm long; leaves not more than 1.5–6 cm long, 1.5–2.5 mm broad, linear, the same breadth throughout, with 5 main nerves, in upper part denticulate (obscurely so in lower part), abruptly narrowed at apex to a ligulate obtuse and often somewhat retuse tip; stipules to 1 cm long; peduncle ca. 2 mm long, compressed; inflorescence ca. 1 cm long, somewhat interrupted; fruit small, developing very rarely. July–August. (Plate XII, Figure 5 a–b).

Rivers and lakes.—Far East: Kamch., Uss.; few locations in E. Siberia: Yen. (Chuna-Angara watershed, Chuna River). **Gen. distr.**: Jap.-Ch. Described from the Sungari River. Type in Leningrad.

Section 4. **BATRASHOSERIS** Irmisch in Abh. Naturw. Ver. Sachs. u Thüringen, Halle II (1858) 17. Stem compressed, 2-channeled; leaves

* From Greek eu, good, true, and potamogeton, pondweed.

broadly linear, often undulate, dentate, without sheaths; stipules retuse; fruits long-beaked, united at base.

Cycle 3. *Crispi* Hagstr. Cr. res. Pot. etc., p. 57. Characters of the section.

8. **P. crispus** L. Sp. pl. (1753) 126; Ldb. Fl. Ross. IV, 28; Kryl., Fl. Zap. Sib. 1, 110.— *P. serrulatus* Schrad. et Opiz in Flora V (1822), 267.— Ic.: Fryer et Benn. Pot. Brit. Isles, pl. 29, 30.— Exs.: HFR, No. 439; Pl. Finl. 432.

Perennial; rhizome slender, much branched; stem 3–10 cm long, branched, ca. 2 mm in diameter, with internodes 1–2 (–5) cm long; leaves all immersed, lanceolate to linear-lanceolate, 4–6 (–9) cm long, 0.7–1.3 cm broad, sessile, rounded at base, commonly short-acuminate, sharply serrulate, mostly undulate or crisped, rarely flat (*P. serrulatus* Schrad.), the main lateral nerves submarginal; stipules mostly ca. 1 cm long, broad, coriaceous, caducous, the lower ones adnate to leaf; peduncle 2–3 cm long, of uniform thickness, slightly curved; spike short, 7–10-flowered, loose; fruit small, ca. 1.5 mm long, obliquely obovoid, obtusely 3-keeled on the back, the terminal falcate beak as long as the body. June to fall. (Plate XII, Figure 6 a–b).

241 In quiet or sluggish water: ponds, creeks, lakes, canals, more rarely rivers, etc.—European part: all regions except the Arctic, Kar.-Lap., Dv.-Pech.; the whole of the Caucasus; W. Siberia: Alt., U. Tob., Irt.; E. Siberia: Dau.; Far East: Uss.; Centr. Asia: Ar.-Casp., Balkh., Kyz. K., Syr. D., Pam.-Al. **Gen. distr.:** Eur., Afr., Asia, Austr., and N. Am. Described from Europe. Type in London.

Section 5. **CHLOEPHYLLI** Koch. Syn. 1 (1837) 676.

Leaves all submersed, usually all alike, linear or very rarely the upper ones dilated and bladelike toward apex.

Cycle 1. *Compressi* (Fries) Hagstr. Cr. res. Pot., p. 64. Stem strongly compressed, as broad or about as broad as the leaves; leaves linear, entire, many-nerved, broadly rounded at base, long-acuminate at apex; style very short, with an ovoid-oblong stigma; fruit often keeled on the back.

9. **P. zosterifolius** Schum. Enum. pl. Saelland., Vol. 1 (1801) 50.— *P. compressus* Fr. Novit. Fl. Suer. ed. 2 (1828) 44 et auct. plur., an L. p. p.? Ldb. Fl. Ross. IV, 29; Kryl., Fl. Zap. Sib. 1, 110.— Ic.: Rchb., Fl. germ., Vol. VII (1845), tab. 27; Fryer et Bennett Pot. Brit. Isl. pl. 50.— Exs.: HFR, No. 1636.

Perennial; rhizome elongated, terete, often wanting (plant developing from a winter bud); stem strongly compressed, 2–3 mm broad, with internodes (3–) 5–20 cm long; leaves sessile, linear, 5–20 cm long, 2–4 mm broad, usually rounded and mucronate at apex, rarely pointed, with 5 (rarely 3) primary and numerous secondary nerves; stipules 2–5 cm

long, whitish, the lower round-tipped and mucronate, the upper acute, fibrous-persistent; peduncles 2–4 cm long, stout, about 2 cm in diameter throughout, 2–4 times as long as inflorescence; inflorescence oblong, dense; fruit ca. 2 mm long, subreniform, slightly flattened, the ventral margin slightly convex, the dorsal margin rounded and obtusely 3-keeled, the beak central. May–August. (Plate XII, Figure 7 a–b).

Lakes, ponds, and rarely rivers. — European part: Kar. -Lap., Dv.-Pech., Lad. -Ilm., V. -Kama, U. V., U. Dnp., M. Dnp., V. -Don, Transv.; W. Siberia: Ob, Alt.; E. Siberia: Yen., Dau., Lena-Kol.; Far East: Kamch., Uss. **Gen. distr.** : W. Eur., Japan, N. Am. Described from Europe.

10. **P. Henningii** Benn. in Journ. Bot. XLVIII (1910) 151.

242 Perennial; resembling *P. zosterifolius* Schum., but stem only half as broad as in the preceding species, much less compressed; leaves 10 cm long, 4 mm broad, with 7 closely approximate median nerves, these interconnected by numerous transversal veins leaving them at a right angle, and in addition but 2 thick lateral nerves and 6 slender ones; stipules 1–2 cm long, half as long as in *P. zosterifolius*, long-mucronate; fruit resembling that of *P. acutifolius*, with 1 median and 2 lateral dorsal keels, the beak forming an extension of the ventral margin.

Standing water. L. Don? or Cisc.? Endemic? Described from "stagnis prope sylv. St. Marian" (where?). Cotype in Leningrad.

Note. An enigmatic species, in need of critical study.

11. **P. acutifolius** Link in Roem. et Schult. Syst. veg. III (1818) 513; Ldb. Fl. Ross. IV, 29. — *P. cuspidatus* Schrad. ap. Smith Engl. Fl., ed. 2 (1828) 235. — Ic. : Rchb. Ic. Fl. Germ. VII (1845) t. 26; Fryer et Bennett Pot. Brit. Isl., pl. 51. — Exs. : HFR, No. 288.

Perennial; rhizome commonly developed; stem mostly 50–60 cm long, compressed, to 3.5 mm broad, dichotomously branched, the branches crowded, leaves linear, 5–12 cm long, ca. 3.5 mm broad, long-acuminate, with 3 primary and ca. 18 secondary nerves; midrib consisting of 6 approximate nerves, translucent; stipules 1–2.5 cm long, brownish-whitish, acute, persistent; peduncles 5–10 (–15) mm long, equaling the inflorescence, of uniform thickness throughout; inflorescence short, loosely 4–6-flowered; fruit large, ca. 3 mm long, scarcely narrower than long, nearly round, compressed laterally, flattened ventrally, toothed at base, the recurved beak ca. 1 mm long, forming an extension of the ventral margin; the back slightly 3-keeled. June–August. (Plate XII, Figure 8 a–b).

In standing water (mostly small water bodies — lakelets, ponds, and canals). — European part: Lad. -Ilm., V. -Don, Bes., Bl., L. Don, L. V. **Gen. distr.** : W. Europe.

Cycle 2. *Oxyphylli* Hagstr. Cr. res. Pot. 82. Stem more or less compressed, relatively slender, with long internodes and 2 tubercles at the nodes; leaves linear, many-nerved, more or less rounded at base, acute or acuminate; style short, with a small stigma; fruit ovoid, slightly compressed.

12. **P. sibiricus** A. Benn. in Journ. of Bot., XXVIII (1890) 300.

Perennial; stem compressed, slender, ca. 1 mm broad, with leaf clusters in the axils of primary leaves (as in *P. Friesii* Rupr.); leaves narrowly

linear, 3–4.5 cm long, 1.5–2 mm broad, somewhat narrowed toward base, sessile, with 2 basal tubercles, acuminate or acute, 15–21-nerved, the median nerves close to midrib, thicker than the rest and joined by transverse connections, the lateral ones faint, with few transverse connections; stipules
243 1–1.5 cm long, obtuse, pale; peduncle 1.2–2 cm long, somewhat broadened upward, curved in fruit; inflorescence in fruit subspherical, ca. 1 cm long, dense, 12–16-flowered; fruit ca. 2.5 mm long and 1.5 mm broad, obovoid, compressed, the ventral margin semiovate, the dorsal margin convex, 3-keeled, the median keel more prominent than the lateral ones, the beak central, thick and recurved.

Rivers. — E. Siberia: Lena-Kol. (Vilyui River, 64°). **Gen. distr. :** Endemic. Described from plants collected by Maak in Yakutia (Vilyui River). Cotype in Leningrad.

13. **P. subsibiricus** Hagstr. Crit. Res. Pot. in Kgl. Sv. Vetenskap. Handl. 55, No. 5 (1916) 86. — Ic. : Hagstr., l. c., fig. 33.

Perennial; stem ca. 50 cm long, slender, 0.5–1 mm broad, slightly compressed, with 3–7 internodes, weakly branched; leaves narrowly linear, the primary 4–6 cm long and ca. 2 mm broad, the uppermost ca. 4 cm long, rounded at base, acuminate, 13–17-nerved; stipules ca. 15 mm long, obtuse, split, brownish, with basal glands and with 10–13 nerves between the keels; peduncle 2–3.5 cm long, uniformly thick throughout; inflorescence rather dense, of 3 or 4 whorls; style very short, with flattened stigma; fruit so far unknown. August.

Lakelets in the tundra. — Arc. Siberia (Yenisei). **Gen. distr. :** Endemic. Described from the vicinity of Dudinka village and from Nikandrovskii Island. Type in Stockholm.

14. **P. manschuriensis** A. Benn. in Journ. Bot., LXII (1904) 76.

Perennial; stem to 75 cm long, compressed, slender, ca. 1 mm broad, irregularly branched, with internodes to 8 cm long and with leaf clusters (reduced branches) in the axils of the upper leaves; leaves narrowly linear, 3.5–10 cm long, 1.3–2 mm broad, stiffish, acuminate or long-attenuate at apex, with a thick midnerve and 12–16 lateral often obsolescent nerves; stipules ca. 2 cm long, pale; peduncles 2–4 (–5.5) cm long, rather slender, uniformly thick throughout; inflorescence ca. 8 mm long, in fruit ca. 1 cm; fruit ca. 3 mm long, obovoid, compressed, the ventral margin convex, with 2 straight approximate teeth at base, the dorsal face rounded, with a sharp undulate keel; beak thick, somewhat recurved. Plants similar in aspect to *P. Freisii* Rupr. July.

Lakelets, backwaters, and banks of streams. — Far East: Ze.-Bu., Uss. **Gen. distr. :** Manchuria. Described from the Sungari River near Taladzhao. Type in Leningrad.

15. **P. oxyphyllus** Miquel in Ann. Mus. Bot. Lugd. Batav. III (1867) 161. — Ic. : Hagstr. Crit. res. Potam., fig. 32.

244 Perennial; stem rather slightly compressed, branched; leaves sessile, linear, markedly thickened toward both ends, 5–7 cm long, below the middle ca. 2–2.5 mm broad, somewhat rounded at base, gradually long-acuminate and asymmetric at apex, the midnerve accompanied on each side by 2 or 3 approximate slender nerves and 5–8 distant nerves, of these one more prominent than the rest; peduncle 1.5–2 cm long, slightly thickened upward;

inflorescence 4–7 mm long, dense, but at length the whorls somewhat spreading out; style short but distinct, thickened above, with a small ovoid-globose stigma; fruit obliquely ovoid, slightly compressed. June–July. (Plate XII, Figure 9).

Rivers and lakes. Far East: Uss. **Gen. distr.** : Japan, Korea. Described from Japan.

Cycle 3. *Monogyni* Hagst. Cr. res. Pot. 74. Stem terete; leaves narrowly linear, very acute, 1–3-nerved, narrowed at apex and at base; style very short, with an ovoid stigma; fruit often wrinkled on the back.

16. *P. trichoides* Cham. et Schlecht. in *Linnaea* II (1827) 175; Ldb. Fl. Ross. IV, 30. — *P. condylocarpus* Tausch in Bot. Zeit. II (1836) 413. — *P. monogynus* Gay ap. Coss. et Germ. Fl. Paris (1843) suppl., p. 89. — Ic.: Cham. et Schlecht., l. c., tab. 4, fig. 6; Rchb. Ic. Fl. Germ. VII (1845) tab. 21, fig. 34; Fryer et Bennett, l. c., pl. 56.

Perennial; rhizome filiform, often branched; stem 30–50 cm long, filiform, repeatedly branched, with internodes 2–5 (–10) cm long; leaves 2–5 (–10) cm long, sessile, setaceous, long-acuminate, normally 1-nerved (rarely 3-nerved), without transverse connections; stipules small, to 7 mm long, acutish to acute, subcoriaceous, brownish, caducous; peduncle commonly to 5 cm long, slender, of uniform thickness throughout; inflorescence spherical or oblong-ovoid, 4–8-flowered; fruit ca. 2 mm long, subglobose, the ventral margin almost straight, the dorsal margin rounded, obtusely keeled, with a short straight beak (typical form) or with a large ventral tooth and a tuberculate dorsal keel (*P. condylocarpus* Tausch.). June–August.

Lakelets, ponds, and canals. — European part: Lad. -Ilm., U. V., V. -Kama, M. Dnp., V. -Don, Bl., L. V.; Caucasus: Dag., E. Transc.; W. Siberia: U. Tob.; E. Siberia: Yen. (Ket River valley); Centr. Asia: Ar. -Casp., Balkh. **Gen. distr.** : nearly the whole of W. Eur., Hither Asia, and Africa.

Cycle 4. *Pusilli* (Graebn, l. c., 1907, 106); Hagstr. Cr. res. Pot. 87. Stems somewhat compressed, rarely subterete; leaves linear, 3–5 (–7)-nerved, narrowed at base, more or less obtuse, mucronate, rarely acute, more or less flaccid; style short, with a rounded stigma; fruit obovoid or globose, smooth, with or without a keel.

245 Group A. *Pusilli connati* Hagstr., l. c., 89. Stipules connate, ochreate; leaves mostly gradually narrowed at apex, commonly rather stiff.

17. *P. rutilus* Wolfg. in Roem. et Schult. Sust. Veg. Mant., Vol. III (1827) 362; Shmal'g. II, 535. — *P. caespitosus* Nolte in Rchb. Ic., Vol. VII, (1845) 21. — Ic.: Rchb., l. c., tab. 23, fig. 40. — Exs.: Fr. Herb. Vol. XV, No. 74.

Perennial; stem commonly to 40 cm long, rarely longer, markedly compressed, branched only in lower part, simple above, slender, with long internodes; leaves narrowly linear, 2.5–7.5 cm long, 3-nerved, gradually narrowed at apex, rather stiff, the lower persistent, often reddish-tinged,

frequently with leaf clusters in the axils of primary leaves; stipules ca. 2.5 cm long, acuminate, stiff, very persistent; peduncle 2.5–5 cm long, slightly thickened upward; inflorescence ca. 5 mm long, few-flowered, somewhat interrupted; fruit 1.5–2 mm long, semiovoid, smooth, lustrous, the ventral margin almost straight, prolonged into a straight beak, the dorsal margin rounded, without a keel. July–August. (Plate XII, Figure 10).

Lakes. — European part: Lad. -Ilm., U. V., V. -Kama. **Gen. distr.** : Scand., Centr. Eur., N. Am. Described from Lithuania (Vilnius). Type (or cotype) in Leningrad.

18. **P. Friesii** Rupr. Beitr. Pflanz. Russ. Reichs. IV (1845) 43. — *P. mucronatus* auct. plur. non Schrad.; Kryl., Fl. Zap. Sib. I, 111. — *P. pusillus* var. *major* Fr. Novit. Fl. Suec., ed. 2 (1828) 48; Ldb. Fl. Ross. IV, 30. — Ic.: Rchb. Ic. Fl. Germ. IV (1845), tab. 24; Fryer et Benn., l. c., pl. 53. — Exs.: HFR, No. 289.

Perennial; rhizome rather long-creeping, slender, branched, or wanting (the plants developing from winter-buds); stem more than 1 m long, somewhat compressed, rather slender, slightly branched or almost simple, with leaf clusters (reduced branches) in the axils of upper leaves, the internodes 3–5 (–10) cm long; leaves linear, sessile, (2–) 4–5 (–7) cm long and to 2.5 (commonly 1.5–2) mm broad, acutish or often obtuse and mucronate, commonly 5-nerved, rarely 3- or 7-nerved (the nerves prominent beneath in dry plants), with 2 minute warts at base; stipules slender, 2-cleft; peduncles rather conspicuously broadened toward apex, (2–) 3–4 (–5) cm long; inflorescence 3–10 (15) mm long, few-flowered, at length somewhat interrupted; fruit ca. 2 mm long, obliquely ovoid, slightly compressed, ventrally convex, dorsally rounded, keeled, with 2 prominent lateral lines [rows of lacunae], the central beak straight or slightly recurving. June–August. (Plate XII, Figure 11).

Lakes and rivers. — European part: Lad. -Ilm., U. V., V. -Kama, 246 U. Dnp., M. Dnp., V. -Don, Bl., L. V.; W. Siberia: Alt., U. Tob., Irt.; E. Siberia: Ang. -Say.; Far East: Kamch. **Gen. distr.** : W. Eur., Manchuria (?), N. Am.; also reported for Argentina. Described from Leningrad Region. Type in Leningrad.

19. **P. panormitanus** Biv. -Bern. Nuov. piante ined. (1838) 6. — *P. gracilis* Fries Nov. fl. Suec. (1828) 50 non Wolfg. — *P. Noltei* A. Benn. in Journ. of Bot. (1890) 30. — Ic.: Hagstr. crit. res. Potam. fig. 38, 39.

Perennial; stem filiform, subterete, branched in lower part, often simple above; upper internodes 6–10 cm long; leaves narrowly linear, acute, 3-nerved, rather stiff, yellowish-green, the midrib prominent beneath, the lateral nerves faint, joining the midrib near apex at an acute angle; stipules rather firm, light brownish, connate for 2/3 their length; winter-buds 12–15 mm long, breaking off together with the supporting branchlets; peduncle long, filiform; inflorescence small, of 2 or 3 subremote whorls; fruit 1.7–2 mm long, 1.1–1.5 mm broad, obovoid, almost straight ventrally, olivaceous, the beak short and slender. June–August. (Plate XII, Figure 12).

Lakes and rivers. Sparsely distributed over a large area. — European part: Lad. -Ilm. (Leningrad Region), L. V. (Krasnoarmeisk); E. Siberia: Yen. (middle course of Yenisei); Far East: Kamch. **Gen. distr.** : nearly all Eur., Afr., Afghanistan, China, N. Am. Described from Sicily (Palermo).

20. **P. limosellifolius** Maxim. ex Korsh. in AHP XII (1892) 393 s. str.—

Perennial; stem ca. 10 cm long, filiform; submersed leaves narrowly linear, mostly 2–3 cm long, distinctly 1-nerved, without any lateral nerves or transverse connections; floating leaves lanceolate or obovate, 7–10 mm long, 2–3 mm broad, gradually tapering toward base, mostly 3-nerved, with 8–10 conspicuously translucent transversal veins and a dense network of slender veins; peduncle barely 1 cm long, filiform; inflorescence ca. 4–6 mm long, loosely 2–4-flowered (Plate XII, Figure 13 a–b).

Far East: Uss. Gen. distr.: Jap.-Ch. Described from middle course of the Ussuri River (Buldshi). Type in Leningrad.

Group B. *Pusilli convoluti* Hagstr. Crit. res. Pot. p. 89. Stipules splitting, convolute; leaves flaccid, mostly round-tipped and mucronate.

21. **P. obtusifolius** Mert. et Koch Deutschl. Fl., ed. 3, Vol. I (1823) 855; Ldb. Fl. Ross. IV, 29; Kryl., Fl. Zap. Sib. I, 111; Shmal'g. II, 535. Ic.: Rchb. Fl. Germ. VII (1845), tab. 25.—Exs.: Fr. Herb. norm. V, No. 80.

247 Perennial; rhizome creeping, branched, or wanting (plants developing from winter-buds); stem nearly 1 m long, slightly compressed, much branched, with internodes 1–3 (–8) cm long; leaves linear, 2–8 cm long, 1–3 mm broad, slightly tapering toward base, sessile, obtuse and minutely mucronulate, 3- or rarely 5-nerved, without intervening secondary nerves, often with large basal warts [glands]; stipules ca. 1.5 cm long, broad, acutish, lurid; peduncle to 1 cm long, rather slender, uniformly thick throughout; inflorescence oblong-ovoid, 5–7 mm long, densely 6–8-flowered; fruit obliquely obovoid, ca. 2 mm long, slightly compressed, the ventral margin convex, the dorsal rounded, obtusely 3-keeled, sometimes tuberculate at base, the apical beak ca. 1 mm long. June–August. (Plate XII, Figure 14).

Standing water: ponds, canals, etc.—European part: Kar.-Lap., Lad.-Ilm., U. V., U. Dnp., M. Dnp., L. V. (Krasnoarmeisk); Caucasus: Cisc.(?); W. Siberia: U. Tob., Alt., Irt.; E. Siberia: Uen., Ang.-Say., Lena-Kol.; Centr. Asia: T. Sh. (Ichkei-Tau, Chimkent). Gen. distr.: nearly all W. Eur., Mong., Persia, N. Am. Described from Germany.

22. **P. pusillus** L. Sp. pl. (1753) 127; Ldb. Fl. Ross. IV, 29; Kryl., Fl. Zap. Sib. I, 112.—Ic.: Fryer et Bennett Pot. Brit. Isl., pl. 55.—Exs.: Fl. As. Med., No. 412; HFR, No. 134.

Perennial; rhizome always wanting; stem 15–70 cm long, subterete, simple or strongly branched toward apex, with internodes 1.5–3 (–7) cm long; leaves linear, 1.5–3 (–5) cm long, to 1.5 mm broad, obtuse and mucronate, more rarely acute, with 2 basal glands, 3-nerved, the midnerve not prominent, the lateral nerves strongly curved and joining the midnerve at a right angle, the space between the middle and lateral nerves often covered by a network of veins but sometimes plain green; stipules small, translucent, commonly obtuse, free throughout; peduncle 1–3 cm long, slender, of uniform thickness throughout; inflorescence one-fourth to one-half the length of peduncle, not interrupted, 3–13-flowered, with 3–6 approximate 2- or 3-flowered whorls; fruit mostly 1–2 mm long, obliquely ellipsoid, slightly compressed, the ventral margin distinctly convex, the dorsal semiobovoid, faintly 3-keeled, pointed at apex, with a short central beak. June–September. (Plate XII, Figure 15).

Lakelets, ponds, canals, and rarely lakes. — All European part except the Arctic region; Caucasus: Cisc., W. Transc., S. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Ang.-Say., Dau.; Far East: Uss., Sakh.; Centr. Asia: Balkh., Ar.-Casp., Syr D., Mtn. Turkm. **Gen. distr.** : almost cosmopolitan, but absent in Australia and Polynesia. Described from Europe.

- 248 Section **HETEROPHYLLI** Koch. Syn. I (1836) 672. Leaves of two kinds: linear, lanceolate, or oblong submersed leaves and broader floating ones; rarely all leaves submersed, tapering toward base.

Cycle 1. *Javanici* Graebn. in Engl. Das Pflanzenr. IV, 11 (1907) 45. Stem terete or slightly compressed; leaves always of two kinds: the submersed narrowly linear, few-nerved, gradually acuminate at apex; the floating short-petioled, few-nerved; style rather long; fruit keeled, the keel often wrinkled or prickly.

23. **P. cristatus** Rgl. et Maack Fl. Ussur. (1861) 139. — Ic.: Rgl. et Maack, l. c., t. 10, f. 3–6; Makino Ill. Fl. Japan 2 (1891), t. 55.

- Perennial; rhizome slender, long-creeping; stem short, usually not more than 20 cm long, filiform; submersed leaves narrowly linear, 2–5 (–6) cm long, 0.5–1 mm broad, with 2 or 3 thin parallel nerves on each side of the midrib and close to it, all interconnected by transversal veins; floating leaves lanceolate, oblong, or elliptic, 1.5–2.5 cm long, 3–10 mm broad, obtusish, 5- or commonly 7-nerved, the nerves concave beneath; stipules narrow, pointed; peduncle short, commonly ca. 1 cm (to 1.5 cm) long, somewhat thicker than the stem; spike 0.5–1 cm long, dense, capitate or oblong; fruit obliquely obovoid, ca. 1.5 mm long, with a large dorsal tubercle at about the center, the ventral margin with a crested long-toothed keel and 2 long hornlike outgrowths at base; beak to 1.5 mm long (Plate XII, Figure 17).
- 251 Lakelets, oxbows, and ricefields. — Far East: Uss. **Gen. distr.** : Jap.-Ch. Described from lakelets along the middle course of the Ussuri River. Type in Leningrad.

24. **P. javanicus** Hasskarl in Act. Soc. Ind. Neerl. V, 1 (1856) 26. — *P. tenuicaulis* F. Müll. Fragm. Fl. Austr. I (1858) 90, 244. — *P. parviflorus* Buchen. Reliq. Rutenb. in Abh. Naturw. Ver. Brem. VII (1880) 32–33. — Ic.: Graebn. in Engl. Pflanzenr. IV, 11 (1907), fig. 14 A–C.

Perennial; stem filiform, terete or subterete, branched, with rather long internodes; submersed leaves narrowly linear, ca. 1 cm long and 1 mm broad, flaccid, tapering at both ends, long-acuminate, with 3 primary nerves in the middle part and 4–6 faint nerves between them, with transverse connections and a central network; floating leaves oblong-elliptic to lanceolate, (1.3–) 2–3.5 cm long, to 1 cm broad, tapering into a petiole, commonly 7-nerved, the nerves mostly slightly concave beneath, the lateral nerves sometimes running along the margin and indistinct; stipules thin; peduncle ca. 2 cm long, not thickened; inflorescence 8–15 mm long, dense; stigma narrow, oblong; fruit small, semicordate, the ventral margin almost



PLATE XII

1. *Zostera marina* L.: a) leaf tip; b) fruit.— 2. *Z. minor* (Cavol) Nolte: leaf tip.—
 3. *Potamogeton filiformis* Pers.: a) leaf tip; b) leaf sheath in section; c) fruit.— 4. *P. pecti-*
natus L.: a) leaf tip; b) leaf sheath in section; c) fruit; d) fruiting inflorescence; e) portion of stem.—
 5. *P. Maackianus* A.Benn.: a) leaf tip; b) fruit.— 6. *P. crispus* L.: a) leaf tip; b) fruits.—
 7. *P. zosterifolius* Schum.: a) leaf tip; b) fruit.— 8. *P. acutifolius* Link.: a) leaf tip; b) fruit.—
 9. *P. oxyphyllus* Miq.: leaf tip.— 10. *P. rutilus* Wolf: leaf tip.— 11. *P. Friesii* Rupr.: leaf tip.—
 12. *P. panormitanus* Biv.: leaf tip.— 13. *P. limosellifolius* Max.: a) tip of submersed leaf;
 b) floating leaf.— 14. *P. obtusifolius* M.K.: leaf tip.— 15. *P. pusillus* L.: leaf tip.—
 16. *P. javanicus* Haask.: a) tip of submersed leaf; b) floating leaf; c) fruit.— 17. *P. cristatus* Rgl.
 et Maack: fruit.— 18. *P. alpinus* Balb.: a) floating leaf; b) fruit.— 19. *P. tenuifolius* Raf.: fruit.—
 20. *P. nodosus* Poir.: floating leaf.— 21. *P. natans* L.: a) floating leaf; b) fruit.— 22. *P. hetero-*
phyllus Schreb.: a) tip of submersed leaf; b) floating leaf; c) fruit.— 23. *P. lucens* L.: a) summit of
 stem; b) outgrowth of filament; c) fruit.— 24. *P. malainus* Miq.: a) leaf tip; b) lower part of a young
 leaf; c) fruit.— 25. *P. praelongus* Wulf.: a) leaf tip; b) fruit.— 26. *P. perfoliatus* L.: a) leaf with
 a portion of stem; b) leaf tip; c) fruit.— 27. *Groenlandia densa* (L.) Fourr.: a) outgrowth of stamen;
 b) fruit.

straight, prolonged into a beak ca. 1 mm long, the dorsal margin convex, with a pronounced and often tuberculate keel; embryo horseshoe-shaped. (Plate XII, Figure 16 a—c).

Lakelets and oxbows. — Far East: Uss. **Gen. distr.** : S. and W. Asia, Afr., Austr. Described from Java.

25. **P. asiaticus** A. Benn. in l'Annuaire Cons. Génève (1905) 103. — Exs. : HFR, No. 1934.

Perennial; stem terete, ca. 40 cm long, branching at nearly a right angle, the branches often abbreviated, bearing 3–5 crowded terminal leaves forming a winter-bud; submersed leaves 2–4 cm long, linear-lanceolate or the lower ones subsetaceous, stiff, the nerves not reaching the margin, forming a compact elongated looped central network; floating leaves oblong or partly linear-lanceolate, ca. 12 mm long, with 9 primary nerves and numerous transverse connections, tapering into a petiole 5–12 mm long; stipules ca. 6 mm long, broad, caducous; peduncles 1–2 cm long, of uniform thickness throughout; inflorescence 8–15 mm long, dense; fruit small, the ventral margin almost straight, with a more or less pronounced tooth at center, the dorsal margin rounded, with 3 minute basal tubercles, with a sharp median keel and rounded inconspicuous lateral keels, the beak apparently forming an extension of the ventral margin.

Far East: Uss. (so far only unreliable reports). **Gen. distr.** : Manch. Described from Manchuria (Wang Fang Kow). Type in Leningrad.

252 Note. A little known, very critical species.

26. **P. miduhikimo** Makino Ill. Fl. Jap. (1891) 2. — Ic. : Makino, l. c., tab. 54.

Perennial; rhizome filiform; stem filiform, compressed, rather rigid, much branched; submersed leaves narrowly linear, elongate, 1–3-nerved, flat, cuneate at base; floating leaves oblong to oblong-lanceolate, 1.4–2.2 cm long, 4–6 mm broad, with subparallel margins, tapering at both ends or often almost obtusely angular, with 5 nerves strongly concave beneath, petiolate, the filiform petiole as long as or longer than the blade; stipules elongate, scarious, the upper ones obtuse; peduncle thickened, often curved; inflorescence shorter than the peduncle, rather loosely 4–8-flowered; flowers small; style short, with a subterminal stigma; fruit 1–3 mm long, ovoid to broadly ovoid, compressed; embryo spirally coiled.

Far East: Uss. **Gen. distr.** : Japan. Described from Japan.

Cycle 2. Alpini Graebn. in Engl. Pflanzenr. IV, 11 (1907) 70 em. Hagstr. Cr. res. Pot. 141. Stems terete, simple; submersed leaves sessile, entire; floating leaves obtuse, tapering at base into a short petiole; stipules scarious, round-tipped or retuse; style slender, elongate; stigma oblong; fruit lenticular, keeled.

27. **P. alpinus** Balbis Miscell. bot. in Mem. Ac. Sc. Turin (1804) 327; Kryl., Fl. Zap. Sib. 1, 106. — **P. rufescens** Schrad. in Cham. Adnot. ad Kunth Fl. Berol. (1815) 5. — **P. purpurascens** Seidl. in Presl Fl. Čechica (1819) 25. — Ic. : Rchb. Ic. Fl. Germ. VII (1845), t. 32; Fryer et Benn. Pot. Br. Isl., pl. 18–20. — Exs: HFR, No. 642.

Perennial; rhizome much branched; stem 5 cm to 2 m long, often reddish; submersed leaves lanceolate, 7–15 (–25) cm long, (0.5–) 1–2.5 (–3.5) cm broad, sessile, narrowed to both ends, obtusish, entire, dull, (5–) 7–13-nerved, with a distinct network of veins along midrib; floating leaves coriaceous, mostly spatulate-obovate, tapering into the petiole, this shorter than the blade, commonly about one-third its length; floating leaves sometimes wanting; all leaves dark green, slightly reddish-tinged, usually turning red here and there in drying; stipules ca. 6 cm long, firm, mostly reddish-brown; peduncle 6–15 cm long, not thickened above; inflorescence to 4 cm long, dense; fruit ca. 3 mm long, compressed-ovoid, the dorsal margin convex, sharply keeled below, the ventral margin somewhat less convex, sharp-keeled, gradually narrowed upward into the nearly central beak, this almost straight or slightly recurving. June–August. (Plate XII, Figure 18 a–b).

Mostly in standing water — lakelets, ponds, and canals, rarely brooks or small streams. — European part: Kar. -Lap., Dv. -Pech., Lad. -Ilm., 253 V. -Kama, U. V., V. -Dnp., M. Dnp., V. -Don, Transv.; Caucasus: Cisc., W. Transc., E. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen.; Ang. -Say.; Centr. Asia: Ar. -Casp. (The reports for E. Siberia and the Far East probably refer to the next species). **Gen. distr.** : N. and Centr. Eur. Described from N. Italy.

Economic importance. Fish often spawn in extensive thickets formed by this species.

28. *P. tenuifolius* Raf. Med. Repos. Lex. 3, II (1811) 409. — *P. lucens* Michx. Fl. bor. -Am. I (1803) 101 non L. — *P. microstachys* Wolfg. ex Schultes Mant. III (1827) 360. — *P. obrutus* Wood Class. Bk., ed. 2 (1847) 525. — Ic. : Fernald in Rhodora, Vol. 32 (1930), pl. 197 (flor. et fr.).

Perennial; stem simple, slender; leaves linear-lanceolate, 7–25 cm long, 0.5–1.5 mm broad, narrower than those of *P. alpinus*, commonly with 7 (sometimes 5, rarely 9 or 11) primary nerves (var. *typicus* Fernald), or narrowly elliptic-oblong, 4–8 (–12) cm long, 0.8–2 cm broad, 7–13-nerved (var. *subellipticus* Fernald); peduncle long; inflorescence looser than in *P. alpinus*, the lower whorls often subremote; fruit broader than that of *P. alpinus*, the dorsal margin semicircular, the slightly convex ventral margin prolonged into a very short often recurved lateral beak. In other characters resembling *P. alpinus*. (Plate XII, Figure 19).

Standing water. — E. Siberia: Lena-Kol., Dau.; Far East: Kamch., Ze. -Bu. **Gen. distr.** : Japan, Aleutian Islands, N. Am. Described from North America.

Cycle 3. *Amplifolii* Hagstr. Cr. res. Pot. 151. Stem terete; leaves of two kinds: submersed leaves more or less petiolate, entire, often mucronate, early decaying; floating leaves long-petioled; style short, thickened upward; fruit large, smooth, keeled or keel-less.

29. *P. Franchetii* Baagoe ex A. Benn. in Journ. of Bot. (1907) 234. — Ic. : Hagstr. Crit. res. Pot., p. 156, fig. 74.

Perennial; stem 20–30 cm long, moderately stout; floating leaves lanceolate to ovate-lanceolate, 4.5–6 cm long, 2–2.5 cm broad, subcoriaceous,

not folded at base, the petiole 5.5–11.5 cm long; stipules 2.5–3.5 cm long, acute; peduncle 6.5–7.5 cm long, slightly tapering off upward; fruit large, ca. 2.5 mm long and 1.5 mm broad, obliquely obovoid, somewhat compressed, the ventral margin slightly rounded, the dorsal convex, with a somewhat prominent median keel and faint lateral keels; beak facial, its tip at one level with the fruit apex.

Oxbow lakelets. — Far East: reported for Kamch. and Uss. **Gen. distr. :** Japan. Described from Japan (Yokosuka).

30. *P. digynus* Wall. Cat. (1828) n. 5177; Hook Fl. Brit. Ind. (1894) 566. — *P. perversus* A. Benn. in Philipp. Journ. Science IX (1914) 343. — *P. Tepperi* auct. p. p.

254 Perennial; stem 15–25 cm long, simple; submersed leaves ca. 10 cm long and 1–3 cm broad, lanceolate to ovate-lanceolate, narrowed to base and apex, 11-nerved; floating leaves ca. 7 cm long and 3 cm broad, ovate to ovate-lanceolate, narrowed at base, 13–16-nerved, coriaceous; petiole 4–10 cm long; stipules caducous; peduncle 5–7 cm long; inflorescence 2–3 cm long, dense; fruit compressed-semiobovoid, the ventral margin convex and gibbous about the middle, the dorsal margin semicircular, with a sharp median keel and faint lateral keels.

Reported for E. Siberia: Lena-Kol. (Lena estuary); apparently occurring also in the Far East: Uss. **Gen. distr. :** Japan, China, Philippine Islands. Described from Nepal. Type in London.

31. *P. Fryeri* A. Benn. in Journ. of Bot. (1907) 234. — Ic. : Hagstr. Crit. Res. Pot., p. 158, fig. 76.

Perennial; stem unbranched, 0.5–1 m long, stout; submersed leaves variable in shape, mostly linear-lanceolate, often folded and arcuate, 7-nerved; floating leaves 10–15 cm long, oblanceolate to elliptic, narrowed at base into the petiole, without lateral folds, acutish to acute, with 21–34 longitudinal nerves and very numerous branched lateral veins; petiole 10–15 cm long; stipules 5–10 cm long, acutish, stiff, fibrous-persistent from the numerous firm nerves; peduncle 10–15 cm long, somewhat broadened upward but narrowed at the inflorescence base; inflorescence 2 cm long, dense; fruit 5 mm long, 2.5 mm broad, the ventral margin straight, the dorsal margin rounded, with a sharp median keel and 2 faint lateral keels; beak 1.5 mm long, slightly recurved; embryo large, semiannular.

Reported by Hagström for Sakh. in the Far East. **Gen. distr. :** Japan, Korea. Described from the Nagasaki district. Type in Herb. Baagoe.

Cycle 4. *Nodosi* Hagstr. Crit. res. Pot. 183. Stem terete; submersed leaves petiolate; floating leaves long-petioled, serrulate; style and fruit as in *Amplifolii*.

32. *P. nodosus* Poir. ap. Lam. Enc. mét. bot. suppl. IV (1816) 535. — *P. americanus* Cham. et Schlecht. in Linnaea (1827) 226. — *P. petiolatus* Wolfg. ap. Schultes, Mant. III (1827) 252. — *P. fluitans* auct. mult., non Roth; Ldb. Fl. Ross. IV, 24 (pro parte). — Ic. : Rchb. Ic. Fl. Germ. VII (1845), t. 36; Fryer et Benn. Pot. Brit. Isles (1912), t. 45, 46. — H. F. A. M. 410. — Exs. : HFR, No. 1790; Busch, Mark, Wor. Fl. Cauc., No. 151.

255 Perennial; stem long and stout, much branched; submersed leaves 10–30 cm long, lanceolate, obtusish, 7-nerved, thin and pellucid, promptly decaying, margined with minute fugacious 1-celled denticles; floating leaves coriaceous, elliptic, 2–12 cm long, 0.5–3.5 cm broad, 17–24-nerved, subacute to obtuse, somewhat narrowed at base, the petiole 4–18 cm long; stipules to 10 cm long, brownish; peduncles as thick as stems or usually somewhat thicker, but not thickened toward apex, mostly longer than inflorescence; inflorescence 2–6 cm long, many-flowered, compact; fruit ca. 3.5 cm long, 2.5 cm broad, ovoid-globose, 3-keeled on the back, the median keel prominent, the beak short, slightly recurved. July–August. (Plate XII, Figure 20).

Rivers. European part: M. Dnp., V. -Don, Bl., L. Don, L. V., Crim.; Caucasus: Cisc., W. Transc., S. Transc., Tal.; W. Siberia: U. Tob.; Centr. Asia: Ar. -Casp., Balkh., Syr. D., Kara K., Pam. -Al. (Samara area, Kara-Kalpak ASSR, Amu-Darya). **Gen. distr.:** Eur., Hither and Centr. Asia, Afr., N. and Centr. Am.

Cycle 5. *Natantes* Graebn. in Engl. Pflanzenr., IV, 11 (1907) 42. Stem terete; submersed leaves linear, thick, semiterete, more or less channeled above; floating leaves long-petioled; style and fruit as in *Amplifolii*.

33. **P. natans** L. Sp. pl. (1753) 126; Ldb. Fl. Ross. IV, 23; Kryl., Fl. Zap. Sib. I, 105. — Ic.: Rchb. Ic. fl. germ. VII (1845) 50, fig. 89; Fryer et Benn. Pot. Brit. Isl. tab. 1 (–3). — Exs.: Fr. Herb. Horm. V, No. 73.

Perennial; rhizome long-creeping, much branched, the internodes tuberously thickened in fall; stem 30–120 cm long, stout, simple or few-branched; submersed leaves linear, to 50 cm long and to 1 cm broad, bladeless and reduced to phyllodes; upper leaves lanceolate, subcoriaceous, long-petioled; floating leaves stiff, coriaceous, elliptic, ovate, or oblong, to 12 cm long and 5.5 cm broad, subcordate at base, with 2 distinct lateral basal folds, sometimes abruptly or gradually narrowed into the petiole (fluvial forms), many-nerved, the primary ones prominent beneath, the long petiole sometimes channeled above; stipules to 10 cm long, often exceeding the internodes and the petioles, herbaceous or coriaceous, acuminate, prominently 2-nerved on the back, early caducous; peduncle to 10 cm long, as thick as or slightly thicker than the stem, not thickened above; inflorescence 4–5 cm long, cylindric, dense; fruit obovoid, slightly compressed laterally, the ventral margin slightly convex, the dorsal margin strongly rounded and keeled when dry; beak short, subterminal. June–August. (Plate XII, Figure 21, a–b).

256 Lakes, ponds, oxbows, and canals; rarely in running water. All European part except the Arctic region; Caucasus: Cisc., W. Transc., E. Transc., S. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Kamch., Sakh., Uda, Ze. -Bu., Uss. Centr. Asia: Ar. -Casp., Balkh., T. Sh. **Gen. distr.:** Eur., Asia, N. Am., Afr.

Economic importance. The leaves can be used as feed for small livestock. The tuberous rootstocks are used for food (e.g., by Cossacks), being eaten raw or roasted; they have a nutty flavor. Fish spawn among thickets formed by this plant.

Cycle Lucentes Graebn. in Engl. Pflanzenr. IV, 11 (1907) 75. Stem terete; leaves all submersed, lanceolate, sessile or petiolate, mucronate, serrulate (the lowest sometimes linear as in *Natantes*), or coriaceous floating leaves also present; style short; fruit keeled or rounded on the back.

34. *P. heterophyllus* Schreb. Spicil. Fl. Lips. (1771) 21. — *P. gramineus* L. sp. pl. (1753), 127 p. p. ? et auct. plur.; Ldb. Fl. Ross. IV; 25, Kryl., Fl. Zap. Sib. I, 109 et auct. plur. — *P. oblongus* Ldb., l. c., 23, quoad plantam Schrenkianam ex Urdshar, non Viv. — Ic.: Rchb. Ic. fl. germ. helv. VI, t. 41–43, fig. 71–78; Fryer et Benn. Pot. Brit. Isl. pl. 35. — Exs.: Fr. Herb. norm. VII, 75.

Perennial; rhizome slender, branched; stem to 1 mm long, slender, much branched; leaves very variable in shape; submersed leaves linear-lanceolate, narrowed to both ends, acute, sessile, often mucronate, margined with minute thin denticles, undulate, flat or often folded lengthwise and somewhat falcately curved, 5–7-nerved, with distant oblique transverse veins; floating leaves commonly elliptic, subcoriaceous, almost round at base or short-attenuate into petiole, this as long as or shorter, rarely longer than the blade, in terrestrial forms very short or the blade subsessile (floating leaves sometimes wanting); stipules small, mostly herbaceous, acute, often mucronate, 2-keeled on the back; peduncles commonly 5–10 cm long, sometimes even longer, stout, strongly broadened toward apex (especially in fruit); spike 2.5–5 cm long, shorter than peduncle, stout; fruit small, 2.5–3 mm long, 2 mm broad, obliquely ovoid, compressed laterally, the straight ventral margin terminating in a short beak, the convex dorsal margin with a distinct keel and lateral ribs. June–August. (Plate XII, Figure 22 a–c).

Standing or slow-flowing water. — All European part except the Arctic region; Caucasus: W. Transc. E. Transc., Tal.; W. Siberia: Ob, Alt., U. Tob., Irt.; E. Siberia: Ang.-Say., Dau.; Far East: Kamch., Ze.-Bu., Uss.; Centr. Asia: Balkh. **Gen. distr.:** W. Eur., Manchuria, Japan, N. Am. Described from Germany (Leipzig).

Note. An extremely polymorphic species that will probably have to be divided into a number of races upon detailed study. One of such races is *P. Wolfgangii* Kihlm. Herb. Mus. Fenn. ed. 2, 1 (1889) 128, apparently identical with *P. graminifolius* (Fries Nov. Fl. Suec., ed. 2, 1828, 36) 257 Fryer Pot. Brit. Isl. (1915) 64, recognized by Fryer as an independent species, distinguished by long internodes, flat lorate lower submersed leaves and long-petioled floating leaves, the latter often wanting. Occurring in the USSR in Kar.-Lap., Dv.-Pech., V.-Kama, Lad.-Ilm., Ob, Lena-Kol, Dau.; also in N. Eur.

Hybrids: *P. heterophyllus* Schreb. × *P. lucens* L. (× *P. Zizii* Mert. et Koch Deutschl. Fl. I (1823), 845. — *P. angustifolius* auct., an Presl. Rostl. I (1821) 19 ?). — Exs.: Pl. Finl., No. 429, 430. Represents a series of transitions between the two parental species, approaching more closely one or the other. — European part: Kar.-Lap., V.-Don, Bl.; W. Siberia: U. Tob.

P. heterophyllus Schreb. × *P. natans* L. (× *P. sparganii-folius* Laest. in Fr. Nov. Mant. I (1832) 9). — Resembling to some extent the hybrid *P. lucens* L. × *P. natans* L. (see above), but the upper

leaves with longer petioles and less strongly pointed. — European part: Kar.-Lap., Dv.-Pech., V.-Kama; E. Siberia: Dau.

P. heterophyllus Schreb. × *P. perfoliatus* L. (× *P. nitens* Web. Suppl. fl. Holsat. (1787), 5). — *P. curvifolius* Hartm. Handl. i Skand. Fl. (1820) 78–79. — *P. salicifolius* Wulf. in Schultes Mant. III (1827) 355). — Usually readily distinguishable by the somewhat rounded to subcordate leaf base (much less so than in *P. perfoliatus* L.); occasionally this is to be seen only in leaves of lateral branchlets. — European part: Lad.-Ilm., U. V., V.-Kama, Crim.

35. *P. lucens* L. Sp. pl. (1753) 126; Ldb. Fl. Ross. IV, 26; Kryl., Fl. Zap. Sib. I, 108. — Ic.: Rchb. Ic. Fl. Germ. VII (1845), t. 36; Fryer et Benn. Pot. Brit. Isles (1912) 45, 46. — Exs.: HFR, No. 1790; Busch. Mark. Wor., No. 151.

Perennial; rhizome thick; stem to 3 m long or even longer, stout (3–4 mm in diameter), branched above; leaves all submersed, large, to 30 cm long and 4.5 cm broad, elliptic, lanceolate, or oblong-ovate, rarely suborbicular, narrowed at base, with a short often obsolescent petiole, subacute to obtuse, with a mucro of varying length, undulate margined, often with minute denticles, mostly yellowish-green, lustrous, translucent, the lower leaves often displaying various degrees of reduction, with only the thickened midrib remaining in extreme cases (*P. acuminatus* Schum. Enum. p. Saell. I (1801) 49); stipules very large, to 8 cm long, rounded at apex, 2-nerved, mostly persistent; peduncle to 25 cm long, stout (to 7 mm in diameter), thickened upward; spike to 6 cm long, dense; fruit large, subglobose, with a very obtuse keel and faint lateral ribs; beak very short, central. June–August. (Plate XII, Figure 23 a–c).

258 Lakes and rivers. — All European part, except the Arctic region; Caucasus: Cisc., W. Transc., E. Transc., S. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Ang.-Say.; Centr. Asia: Balkh., Dzu.-Tarb., Ar.-Casp., Kyz. K., Syr. D., Kara K., Pam.-Al. (Gissar Range). **Gen. distr.:** Eur., N. Afr., W. Asia (to Himalayas inclusive), N. Am. Described from Europe.

Note. An interesting form, often recognized as an independent species, is *P. longifolius* Gay Enc. bot. XII (1816) 535. — *P. macrophyllus* Wulf. in Roem. et Schult Mant. III (1827), 358. — *P. lucens* β Ldb. Fl. Ross. IV, 27. A long-leaved plant, characterized by the long stem with elongated internodes; leaves 20–40 cm long, 1–2 cm broad, obscurely denticulate, with petiole to 2 cm long; a form occurring chiefly (though not exclusively) in rivers. On account of its sterility and sporadic distribution, some authors suspect a hybrid origin of this form, while others oppose this approach. In the USSR this form occurs in U. V. (Volga River), Yen., Ang.-Say., Dau. It is also known from W. Europe. Described from France.

Economic importance. Used for manuring of fields. Of particular importance for the fish industry.

Hybrids: *P. lucens* L. × *P. natans* L. (= *P. sterilis* Hagstr. Crit. res. on the Potam. (1916) 238. — *P. fluitans* Roth. Tent. Fl. Germ. I (1788), 72 p.p.). — Exs.: HFR, No. 343. — Resembling in aspect *P. nodosus* Poir. and often confounded with it; it is distinguishable by the long-petioled submersed leaves and the thin acuminate floating leaves, very long stipules, complete sterility, and the anatomical structure of stem and petiole. — European part: Lad.-Ilm., U. V.

P. lucens L. × *P. perfoliatus* L. (= *P. decipiens* Nolte in Hans. Herb. Schl. -Holst. -Lauenb. Fl. (1838) N. 715 et in Koch Syn. Fl. Germ. helv. (1844) 779). — *P. lithuanicus* Gorski in Rchb. Ic. :VII (1845), t. 31). — Mostly resembling *P. lucens* L. but readily distinguishable by the rounded leaf base. European part: Lad. -Ilm.

P. lucens L. × *P. praelongus* Wulf. (= *P. Babingtonii* Arth. Benn. in Journ. of Bot. (1894) 204). — European part: U. Dnp.

36. *P. malainus* (malaina) Miq. Ill. Fl. Arch. Ind. (1871) 46. — *P. mucronatus* Presl. Epim. Bot. (1851) 245, non Schrad. — *P. japonicus* Franch. et Sav. Enum. Pl. Jap. 2 (1879) 15 (nomen). — *P. Wrightii* Morong in Bull. Torr. Bot. Club. 13 (1886) 158, t. 59. — *P. tretocarpus* Maxim. in herb. et in litt. — Ic. : Bull. Torr. Bot. Cl. XIII (1886) t. 58.

259 Perennial; stem with internodes ca. 5–30 cm long, branched in upper part; leaves all submersed, alike, oblong to linear-oblong, ca. 5–20 cm long and 0.8–1.7 cm broad, narrowed to both ends, or obtuse or rounded at apex and terminating in a subulate tip 1–7 mm long, crisped, fugaciously denticulate, with 3 pronounced lateral nerves on each side of the thick midrib and a faint fourth marginal nerve, obliquely reticulate-veined, the lower short-petioled, the upper with petiole to 5 cm long; stipules 2–3.5 cm long, scarious, broad, greenish; peduncle rather slender, to 3 mm in diameter when dry, slightly broadened upward, shorter than the leaves, 4–10 cm long; inflorescence ca. 2–4.5 cm long, thin, narrowly cylindric, rather loose; flowers much smaller than those of *P. lucens*. Fruit small, ca. 2 mm long, obovoid, compressed laterally, distinctly 3-keeled on the back, the short beak almost central. (Plate XII, Figure 24 a–c).

Rivers. — Far East: Uss. **Gen. distr.** : Manchuria, Japan, Korea, China, India, Borneo, Celebes, Java, Philippines. Described from the Malay Archipelago.

37. *P. distinctus* A. Benn. Journ. of Bot. LXII (1904) 72. —

Perennial; rhizome long-creeping; stem ca. 40 cm long, branched; leaves of two kinds; lower leaves submersed, linear-lanceolate, to 15 cm long and 2 cm broad, the petiole 3–7.5 cm long; upper leaves floating, subcoriaceous or coriaceous, varying in shape from linear-lanceolate to oblong-lanceolate, 7–14 cm long, 2–3 cm broad, 13–18-nerved, the petiole 4–15 cm long; peduncles 6–9 cm long, rather stout, gradually broadened upward; inflorescence ca. 4 cm long, cylindric, dense; fruit obliquely obovoid, compressed laterally, the ventral margin almost straight, prolonged into a short beak, the dorsal margin semicircular, 3-keeled.

Far East: Uss. **Gen. distr.** : Manchuria, Japan. Described from Japan.

Section 7. **PELTOPSIS** Rouy Fl. Fr. T. XIII (1912) 315. Leaves all submersed, alike, with a rounded or cordate base, amplexicaul.

Cycle 1. *Praelongi* Hagstr. Crit. res. Pot. 250. Stem terete; leaves entire, sessile, semiamplexicaul at base; peduncles not thicker than stem; style distinct, slender; fruit very large, strongly keeled.

38. *P. praelongus* Wulf. Roem. Arch. III 3 (1805) 331; Ldb. Fl. Ross. IV, 27; Kryl., Fl. Zap. Sib. I, 107. — Ic.: Rchb. Ic. Fl. germ. VII (1845) 32. — Exs.: Fr. Herb. norm. IX, No. 14.

Perennial; rhizome long and thick, branched; stem to 3 m long, simple below, branched above, with zigzag internodes; leaves to 15 cm long, 1.5–4.5 cm broad, dark green, elongate ovate-lanceolate, sessile, with rounded or slightly amplexical base, rounded and hooded at apex, the hood often ruptured in dry herbarium specimens and the leaf apex thus apparently
260 2-cleft; stipules large, 1.5–6 cm long, firm, very persistent, stramineous; peduncle ca. 20 cm and sometimes up to 50 cm long; inflorescence 3–6 cm long, rather compactly many-flowered; style short, the large stigma covering its entire upper surface; fruit very large, to 5 (commonly 4) mm long and ca. 3 mm broad, obliquely and broadly obovoid, the almost straight ventral margin prolonged into a short beak, the dorsal margin sharply keeled. June–July. (Plate XII, Figure 25 a–b).

Lakes (often at considerable depth), rarely in rivers. — European part: Kar. -Lap., Lad. -Ilm., U. V., V. -Kama, U. Dnp., M. Dnp., V. -Don; Caucasus: Cisc., E. Transc.; W. Siberia: Ob, U. Tob., Alt.; E. Siberia: Ang. -Say., Dau.; Far East: Kamch., Uda, Ze. -Bu., Okh. (Ayan).
Gen. distr.: N. Eurasia, N. Am. Described from Carniola (Laibach [Ljubljana]).

Cycle *Perfoliati* (Graebn.) Hagstr. Cr. res. Pot. 252. Stem terete; leaves all submersed, sessile, amplexicaul at base, the margin serrulate toward apex; peduncles and pistil as in *Praelongi*. Fruit medium size, rounded on the back.

39. *P. perfoliatus* L. Sp. pl. (1753) 126; Ldb. Fl. Ross. IV, 27; Kryl., Fl. Zap. Sib. I, 106. — *P. amplexicaulis* Karel. in Bull. Soc. nat. Mosc. (1839), 173 (nom. nud). — Ic.: Rchb. fl. germ. VII (1845) t. 39, fig. 53, 54; Fryer et Benn. Pot. Brit. isles, tab. 27, 28. — Exs.: Busch. Mark., Wor. Fl. cauc., No. 152; Fl. As. Med., No. 411.

Perennial; rhizome extensively creeping; stem commonly much branched, rather short or up to 6 m long, the internodes varying greatly in length, not zigzag; leaves to 6 (–12) cm long and 3.5 (–6) cm broad, from suborbicular to oblong-ovate, slightly concave, deeply cordate and amplexicaul at base, scaberulous on the margin from obscure denticulation, commonly obtuse, not hooded, 5–9-nerved and obscurely reticulate-veined at center, dark olivaceous-green; stipules short, thin, whitish, caducous; peduncle to 5 cm long; fruit obliquely obovoid, the convex ventral margin prolonged into a lateral beak ca. 1 mm long, the dorsal margin obtusely and obscurely keeled in maturity. July–August. (Plate XII, Figure 26 a–c).

Rivers, lakes, ponds, and canals; often forming thickets of considerable size. — All European part; Caucasus: Cisc., W. Transc., E. Transc.; W. Siberia: Ob, Alt.; E. Siberia: Yen., Ang. -Say., Dau., Lena-Kol.; Far East: Kamch., Okh., Uda, Sakh., Ze. -Bu., Uss. **Gen. distr.:** Eur., As., N. Afr., N. and Centr. Am., Austr. Described from Europe. Type in London.

Economic importance. Can be used for manuring. Extensive thickets of this plant interfere with the movement of vessels, swimming, etc.

261 Hybrid: *P. perfoliatum* L. × *P. praelongus* Wulf.
(× *P. cognatus* Asch. et Gr. Syn. I (1897) 317). — European part: U. V.

Genus 49. **GROENLANDIA** * J. GAY

J. Gay in Compt. Rend. Ac. Sc., Paris, 8 (1854) 703.

Flowers few in subspherical inflorescences borne in the axils formed by the dichotomously forking stem on hooklike recurved peduncles; outgrowth of connective triangular, pointed at apex; fruit with a thin scarious pericarp; embryo spirally coiled through a number of turns; aquatic herbs; leaves opposite or occasionally in verticels of 3, with semiamplexicaul base, sheathless and exstipulate, only the upper leaves with 2-cleft stipules. For other characters see description of the genus *Potamogeton* L. — Only 1 species.

1. **G. densa** (L.) Fourr. in Ann. Soc. Linn. Lyon, n. ser. XVII (1869), 169. — *Potamogeton densum* L. Sp. pl. (1753) 126 ampl.; Ldb. Fl. Ross. IV, 31. — Ic.: Rchb. Ic. Fl. Germ. VII (1845), t. XXVIII, fig. 46–49. — Exs. Fr. Herb. norm. 10, No. 67.

Perennial; rhizome creeping, ca. 1 mm in diameter, branched; stem ca. 30 cm long, cylindric, dichotomously forking, with internodes 1–6 cm long; leaves rather small, 0.5–6 cm long, 3 mm–1.5 cm broad, ovate to linear-lanceolate, 3–7-nerved, all alike, submersed, translucent, with a broad amplexicaul base, tapering upward, acute to obtuse, often folded lengthwise and recurved, in upper part denticulate; peduncles 0.5–1.5 cm long, shorter than the leaves, terete, slender, at length recurved; spike small, spherical-ovoid, 2–8-flowered; fruit globose-reniform, ca. 3 mm long and 2 mm broad, compressed laterally, sharply keeled on the back, the terminal beak recurved, to 1 mm long. July–September. (Plate XII, Figure 27 a–b).

Lakelets, ponds, rivers, and brooks. — Caucasus: Cisc., S. Transc.

Gen. distr.: W. Eur., N. Afr., Hither and S. Asia. Described from France. Type in London.

Economic importance. According to Asch. and Graebn., this plant finds application for fish culture in Germany and Switzerland, and its growth is artificially encouraged to provide spawning space for fish and protection for the fry.

Genus 50. **RUPPIA** ** L.

L. Gen. pl., ed. 1 (1737) 277.

262 Flowers 2, bisexual, in a spikelike inflorescence inclosed in a foliaceous spathe; perianth none; stamens with very short scalelike filaments; anthers large, the 2 locules divergent from base; pollen grains oblong, crescent-shaped; pistils commonly 4 (sometimes up to 10), initially sessile, at length mostly long-stalked, with a short style, or else the stigma sessile; ovule 1, pendulous; fruit pyriform or often obliquely pyriform. Perennial aquatic

* Named for I. Groenland (1824–1891), known for his studies on hybrids between *Triticum* and *Aegilops*.

** Named for H. Rupp or Ruppius (1688–1719), the author of a flora of Jena.

herbs with submersed stem; leaves linear, 1-nerved, enlarged or sheathing at base. In aspect resembling *Potamogeton pectinatus* L.

1. Peduncle in fruit strongly elongated (up to 10 cm or more) and spirally coiled; fruit ovoid or obliquely ovoid 1. *R. spiralis* L.
- + Peduncle 1–3 cm long, not elongated or spirally coiled in fruit; fruit ovoid-lunate 2. *R. maritima* L.

1. *R. spiralis* L. herb.; Dumort. Fl. belg. (1827) 164. — *Dzieduszyckia limnobia* Rehm. O. B. Z. XVIII (1868) 374. — *R. maritima* β *pedunculata* Hartmann ex Ldb. Fl. Ross. IV, 21. — *R. maritima* var. *spiralis* Moris St. Sard. ed. I (1827) 43; Kryl., Fl. Zap. Sib. I, 115. — Ic.: Engl. Pflanzenr. V, 11, fig. 30. — Exs.: Fr. Herb. norm. XII, 77; Pl. Finl., No. 29, HFR, No. 1139.

Perennial; stem to 40 cm long, filiform, much branched, with internodes to 5 cm long; leaves filiform, to 10 cm long (including sheath), to 1 mm broad, though usually narrower, obtuse; sheaths to 2 mm broad; peduncle after flowering strongly elongated, up to 10–40 cm long, coiled into a broad spiral; anther locules oblong, longer than broad; fruit usually more than 2 mm long, somewhat obliquely ovoid, erect, gradually narrowing at apex, one-fourth to one-third the length of the stalk, this 7–10 mm long. June to fall.

Sea and brackish water near the coast, rarely at a distance from the sea (mostly saline or brackish lakes). — European part: Bl., L. Don, Crim. (Kerch Peninsula); Caucasus: Cisc., Dag. (Derbent), E. Transc. (Tiflis [Tbilisi]), W. Transc.; W. Siberia: Alt.; E. Siberia: Dau.; Far East: Kamch., Uss. (Putyatin Island). **Gen. distr.**: cosmopolitan. Described from Belgium.

Note. In addition to the more or less typical *R. spiralis*, this includes provisionally a number of forms distinctly different but not so far explored. Of interest is, for instance, a form with very narrow and pointed leaves from V. -Don that is somewhat reminiscent of the Mediterranean *R. drepanensis* Tin.

2. *R. maritima* L. herb.; Sp. pl. (1753) 127; Ldb. Fl. IV, 21, crit. II (1824) 66, in Rchb. Ic. Pl. — *R. rostellata* Koch. — *P. maritima* var. *rostrata* Agardh Physiogr. Sällsk. Arsberätt (1823) 37; Krylov, Fl. Zap. Sib. I, 115. — Ic.: Rchb., l. c., tab. CLXXIV, fig. 306 et Ic. Fl. germ. helv. VII (1845), t. XVII, fig. 25. — Exs.: Fr. Herb. norm. VI, No. 68.

- 263 Perennial; plants usually smaller and weaker than those of the preceding species, in the typical form with narrower filiform strongly pointed leaves; peduncle 1–3 (rarely up to 6) cm long, straight or curved, not elongated and not spirally coiled in fruit; anther locules subglobose (about as long as broad); fruit ca. 2 mm long, ovoid-lunate, strongly and obliquely narrowed at apex, the stalk 10–20 mm long, 4–10 times the length of the fruit. June to fall.

Similar habitats to those of the preceding species. — European part: Lad. - Ilm. (Narva River, Staraya Russa), Bl., L. V., Crim.; Caucasus: Cisc.; W. Siberia: U. Tob., Irt., Alt.; Centr. Asia: Ar. - Casp., Kyz. K., Kara K., Syr D., Amu D.; Far East: Uss. **Gen. distr.**: nearly cosmopolitan. Described from the seacoasts of Europe.

Note. A compound species, undoubtedly comprising a number of forms not so far explored in the USSR. Here belongs, for instance, *R. brachypus*

J. Gay in Coss. Not. quelq. pl. crit. I (1848) 10 (Exs. Pl. Finl. 30, 436) with strongly abbreviated fruit stalks (as long as or barely longer than the fruit) that occurs in Lad. -Ilm. (Narva estuary).

Tribe 2. **Zannichellieae** KUNTH.

Kunth: Enum. pl. III (1841) 123.

Flowers unisexual, monoecious, solitary or paired in the leaf axils; style several times as long as the infundibuliform or peltate stigma.

Genus 51. **ZANNICHELLIA** * L.

L. Gen. Pl., ed. I (1737) 278; Sp. pl., ed. I (1753) 969.

Flowers monoecious, the staminate and pistillate flowers closely approximate, axillary; perianth none; stamen 1 (rarely 2), with a short filament; anthers 2-locular, adnate to the connective throughout their length; pistillate flowers inclosed in a translucent caducous involucre; pistils 2-5 (-8), sessile or stalked; style short or elongated; ovule 1, pendulous; fruit oblong, somewhat compressed. Perennial aquatic plants with creeping rhizome and submersed stem; leaves linear, with large stipules, rarely with sheaths and 2 intravaginal scales.

In Quaternary formations of U. V. (Likhvin).

- 1. Style short, less than half the length of the fruit 1. **Z. palustris** L.
- + Style at least half the length of the fruit 2.
- 2. Fruit small, usually not more than 2 mm long, long-stalked 2. **Z. pedunculata** Rchb.
- + Fruit 2.5-3.5 cm long, sessile or nearly so 3. **Z. major** Boenn.

264 1. **Z. palustris** L. Sp. pl. (1753) 969 s. str.; Ldb. Fl. Ross. IV, 22; Kryl., Fl. Zap. Sib. I, 115. — **Z. dentata** Willd. Sp. pl. IV (1805) 181.; **Z. repens** Boenn. Prodr. fl. Monast. (1824) 272. — **Z. polycarpa** Nolte, Novit. Fl. Holsat. (1826) 75; Ldb., l. c., p. 22. — Ic.: Rchb. Ic. fl. germ. helv. VII (1845), t. XVI, fig. 20, 25. — Exs.: Pl. Finl., No. 31, 437.

Perennial; stem creeping and rooting, very slender, filiform, commonly to 10 cm long, much branched; leaves 1.5-4.5 cm long, narrow, often filiform, pale green, acuminate; staminate flowers long-pedicelated; fruit oblong, small and narrow, to 2 mm long (excluding beak), ca. 0.75 mm broad, lunately curved, somewhat compressed, 2-6 on a common stalk, the individual fruits sessile or nearly so, obscurely denticulate or rarely prominently toothed on the back and sometimes also toothed on the ventral margin; style short, less than half the length of the fruit (commonly one-fourth to one-third as long as the fruit); stigma globose, mostly toothed. June-August.

Lakes, rivulets, and canals, mostly in fresh water. — European part: Kar. -Lap., Lad. -Ilm., U. V., V. -Kama, M. Dnp., V. -Don, L. V.; Caucasus: Cisc., E. Transc., W. Transc., Tal.; W. Siberia: Ob, Alt.,

* Named in honor of the botanist Zannichelli who died in 1729 and is known for his studies on the Venetian flora.

U. Tob., Irt.; Far East: Kamch., Uss. ?; Centr. Asia: Balkh., Dzu.-Tarb., T. Sh., Pam.-Al. (Zeravshan). **Gen. distr.** : nearly cosmopolitan, except Australia; some reports, however, undoubtedly refer to the next species. Described from Europe.

Note. Some forms, provisionally referred to this evidently collective species, need special study.

2. *Z. pedunculata* Rchb., in Mössl. Handb. ed. 2, III (1829) 1591. — *Z. pedicellata* Fr. Mant. I (1832) 18; Ldb. Fl. Ross. IV, 22. — *Z. gibberosa* Rchb. Fl. germ. excurs. I (1830) 7. — *Z. maritima* Nolte, Novit. fl. Holsat. (1826) 75 (nomen). — Ic. : Rchb. fl. germ. helv. VII (1845), t. XVI, fig. 21. — Exs. : Fl. As. Med., No. 413.

Perennial; stem creeping, rooting or floating; leaves mostly filiform, 1.5–2 mm long (excluding beak), 2–4 mostly on a fairly long common stalk, each fruit borne on its own slender stalk, this at least half as long as the fruit; dorsal margin of the fruit with a narrow or often broad sinuate tuberculate keel or, upon partial decay of the keel, with distinct tubercles and spinules; sometimes the ventral margin also keeled and tuberculate (*Z. gibberosa* auct.); style long and slender, about half as long or more than half the length of the fruit, usually recurved; stigma often ovoid, toothed or obscurely toothed. June–August.

In similar habitats to those of *Z. palustris*, usually in brackish or saline water (mostly in maritime countries), but growing also in fresh water. European part: Bes., Bl., Crim., L. Don, Transv., L. V.; Caucasus: 265 Cisc., E. Transc., Tal.; W. Siberia: Irt.; E. Siberia: Dau.; Centr. Asia: Ar.-Casp., Syr D. **Gen. distr.** : little known, as the species is not usually distinguished from the preceding one. W. Eur., Afr., Centr. (and S. ?) Asia. Described from Germany (Hamburg).

Note. A compound species, containing forms which have not so far been sufficiently explored and may possibly deserve the designation of distinct species.

3. *Z. major* Boenn. ap. Rchb. Mössl. Handb., ed. 2, III (1828) 1591. — Ic. : Rchb. fl. germ. helv. VII (1845), t. XVI, fig. 25. — Exs. : Wor. et Schelk. Herb. Fl. Cauc., No. 255.

Perennial; stem stronger than in the two other species, to 50 cm long, floating; leaves 2–5 cm long, to 1 mm broad; fruits usually few, often only 2 (to 4) on a short or often elongated thick common stalk, large, 2.5–3.5 mm long, 1–1.5 mm broad, obliquely oblong, sessile or nearly so, the style half as long as the fruit, rather thick, considerably enlarged and somewhat winged at base, keeled or tuberculate dorsally and often also ventrally, somewhat tuberculate laterally; stigma rather large, globose. June–August.

Creeks, estuaries, saline and freshwater coastal lakes, rarely far from the sea. — European part: Bl.; Caucasus: Cisc., W. Transc., E. Transc., Tal.; Centr. Asia: Ar.-Casp., Kara K. **Gen. distr.** : Described from Munster.

Family XVIII. **ZOSTERACEAE** LINDL.*

Monoecious or dioecious plants; inflorescence a 1-sided spadix with a flattened axis, firmly inclosed in the sheath of the terminal leaf (spathe), this opening at length by a longitudinal slit; perianth none; staminate flowers consisting of a single sessile 2-locular anther, the anthers quite distinct; pollen filiform; pollination occurring under water; pistillate flowers with a single pistil, the style terminating in 2 strap-shaped stigmas; ovule 1, pendulous, orthotropous; fruit saccate, 1-seeded.

A representative of the genus *Posydonia* now extinct in the USSR, *P. Rogowiczii* Schmalh., has been found in fossilized state in the Eocene of M.Dnp. (Kiev).

1. Flowers monoecious (or dioecious?); ovary and fruit elongate-ovoid or subcylindric, rounded at base 53. ***Zostera* L.**
- + Flowers dioecious; ovary and fruit broadly ovoid, beaked at apex, deeply cordate at base 54. ***Phyllospadix* Hook.**

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Genus 52. **ZOSTERA** L.

L. Sp. pl. (1753) 968.

Perennial marine herbs; rhizome flattened, creeping, rooting at nodes; stems flattened, branched; branches partly sterile and abbreviated, partly fertile and branched in turn; leaves in 2 ranks, flat, linear, entire, sheathing and ligulate; flowers monoecious (or dioecious?), borne on the side of the "spadix" facing the slit of the sheathing leaf; stamens and pistils disposed in 2 rows, with 1 stamen and 1 pistil at each level; ovary rounded at base; style short; fruit beaked, with a thin pericarp.

In fossilized condition: in the Eocene of M.Dnp. (Kiev) *Z. kiewiensis* Schmalh.; in the Pliocene of E.Tranc. (Apsheron Peninsula) *Zostera* sp.

1. Leaves mostly much more than 2 mm broad, with 3—9 (—13) principal nerves, rounded at apex, the outer nerves distant from the leaf margin; inflorescence without bracts (Section *Alega* Asch.) 2.
- + Leaves commonly not more than 2 mm broad, with 3 principal nerves, mostly more or less retuse at apex, the outer nerves usually running along the margin; inflorescence bearing bracts (retinaculi) (Section *Zosterella* Asch.) 3.
2. Leaves 2—9 mm broad; fruit longitudinally ribbed . . . 1. ***Z. marina* L.**
- + Leaves 5—12 mm broad; fruit smooth 2. ***Z. pacifica* S. Wats.**
3. Leaves distinctly retuse; a European plant 3. ***Z. minor* (Cavol.) Nolte.**
- + Leaves slightly retuse or sometimes almost rounded at apex; a Far Eastern plant 4. ***Z. japonica* Asch. et Gr.**

Section 1. **ALEGA** Asch. in *Linnaea* XXXV (1860) 165. — Inflorescence destitute of retinaculi.

1. ***Z. marina* L.** Sp. pl., 1 (1753) 968; Ldb. Fl. Ross. IV, 20. — *Z. angustifolia* Rchb. Ic. fl. Germ. VII (1845) 3. — Ic.: Rchb., l. c., VII, t. IV, fig. 3, 4. — Exs.: Pl. Finl., No. 423.

* Arranged by S. V. Yuzepchuk.

Perennial; rhizome usually simple, rather thick; stem fairly robust, 60–150 cm long; leaves on the average 50 cm, often up to 1 m long or even longer, (2–) 3–9 mm broad (2–3 mm broad in *Z. angustifolia* Rchb.), narrowly to rather broadly linear, commonly with 3–9 principal nerves, the outer nerves somewhat distant from the margin (when leaf 3-nerved, the outer nerves running about halfway between the midrib and the margin), 4–7 thinner subsidiary nerves situated between the principal nerves, the apex rounded, sometimes mucronulate; leaf sheaths completely closed, 267 without auricles; inflorescence to 8 cm long, many-flowered, the peduncle thickened below the sheath of the spathe, as broad as the inflorescence; bracts none or confined to the 2 lowest flowers, oblong, broad; fruit 2–3.5 mm long, ellipsoid, whitish, longitudinally ribbed. July–August. (Plate XII, Figure 1 a–b).

On sandy or silty sea bottom, to a depth of 10 m, often occurring in river deltas. — European part: Kar. -Lap., Bl., Crim.; Caucasus: Cisc., W. Transc.; Far East: Kamch., Okh., Uda, Sakh., Uss. **Gen. distr.:** all over the coasts of Europe and Asia Minor; N. Am. (Atlantic and Pacific coasts). Described from the Baltic Sea.

Economic importance. Dry leaves of this species are used under the name "sea grass" for mattress filling and upholstery and also serve as packing material. They are gathered on a large scale in some countries of W. Europe (in the Netherlands about 1,000 tons dry weight per annum). They are used in Venice for packing glass articles. Sometimes used also (fresh or burnt) for fertilization of fields and recently also in street paving.

2. *Z. pacifica* S. Wats. in Proc. Am. Acad. Arts and Sc. XXVI (1891) 131. — *Z. marina* var. (?) *latifolia* Morong in Bull. Torr. Bot. Cl. XIII (1886) 160. — *Z. latifolia* Morong in Mem. Torr. Bot. Cl. III, 2 (1893) 63. — Ic.: Mem. Torr. Bot. Cl. III, 2, pl.

Perennial; rhizome very thick; stem robust, to 2–3 m long; leaves 60 cm–1 m long or even longer, 5–12 mm broad, with 5–9 or the broadest with 10–13 principal nerves and 7 or 8 subsidiary nerves; inflorescence 5–8 cm long, many-flowered; fruit 3–5 mm long, ca. 2–3 mm in diameter, broadly ellipsoid, smooth. In other characters resembling the preceding species.

In seawater on sandy ground and near reefs, often forming submerged meadows. — Far East: Uda, Uss. **Gen. distr.:** Jap., N. Am. (Pacific Coast). Described from California "About Pudet Sound" (type collected by Nevius).

Section 2. **ZOSTERELLA** Asch. in Linnaea XXXV (1860) 166. Inflorescence with a bracteate axis.

3. *Z. minor* (Cavol.) Nolte ex Rchb. Ic. Fl. Germ. VII (1845) 2. — *Z. nana* Roth En. pl. Germ. I (1827) 8; Ldb. Fl. Ross. IV, 20; B. Fedtsch. in Fl. cauc. crit. II, 1, 13; Shmal'g. II, 538. — *Z. Noltei* Hornem. in Fl. Dan. (1832), t. 2041. — *Phucagrostis minor* Cavol. Phucagr. (1792) 14, t. 2. — Ic.: Rchb., l. c., t. II, fig. 2. — Exs.: Dörfl. Herb. norm., No. 5329.

Perennial; plants smaller and weaker than those of *Z. marina*; rhizome branched, slender, flexuous; stem 10–40 cm long; leaves 5–20 (–30) cm long,

0.5–2 mm broad, narrowly linear, with 3 principal nerves, of which the outer close to the leaf margin and obsolescent, and 3 or 4 subsidiary nerves on each side, the apex retuse; sheath split at apex, with 2 auricles; inflorescence 1.5 cm long, (3–) 6–12-flowered, the peduncle not thickened
268 below the sheath of the spathe, much narrower than the inflorescence; most flowers subtended by bracts, these 5–6 mm long, lanceolate; fruit 2 mm long, greenish-brown, smooth. June–August.

Seas, often together with *Z. marina* but at lesser depth (usually down to 1 m). — European part: Bl., L. Don, Crim.; Caucasus: W. Transc., E. Transc.; Centr. Asia: Ar.-Casp., Kara K. **Gen. distr.**: North and Baltic seas, Atlantic Ocean (European coast), Mediterranean, Black, and Caspian seas. Described from Italy.

4. ***Z. japonica*** Asch. et Gr. Engl. Das Pflanzenr. IV, II (1907) 32. —

Perennial; stem slender, to 35 cm long or even longer, floating; leaves 15–25 cm long, narrowly linear, ca. 1–2 mm broad, 3-angled, the outer nerves rather close to the leaf margin, the subsidiary nerves obsolescent, the apex obtuse or slightly retuse (often almost rounded); leaf sheaths long and narrow; inflorescence ca. 1.5 cm long, the peduncle uniformly slender, 2–3.5 cm long; fruit oblong, ca. 2–2.5 mm long, lustrous, smooth or obscurely ribbed; in aspect closely approaching the broadleaved pondweed species of the subgenus *Coleogeton*, section *Connati*.

Sea bottom (especially in creeks), in shallows down to a depth of 1 m (often between the shore and the zone of *Z. marina*), especially in silty ground; often forming dense underwater thickets (meadows). — Far East: Kamch., Sakh., Okh., Uda, Uss. **Gen. distr.**: Japan. Described from Honshu, Miyadzu.

Genus 53. **PHYLLOSPADIX** HOOK.

Hook. Fl. bor. amer. II (1839) 171.

Perennial marine herbs with a short thick rhizome and elongated floating branched stems; leaves long, narrowly linear, commonly entire, with an open sheath and a short ligule; flowers dioecious; staminate spadices with 2 rows of alternate anthers, bracteate, the bracts recurved; pistillate spadices with carpels alternating with sterile stamens, subtended by erect bracts; ovary sagittate at base; fruit broadly ovoid, beaked, with 2 acute outgrowths at base. — In USSR only 1 species.

1. ***P. Scouleri*** Hook. Fl. bor. amer. II (1839) 171, t. 186. — Ic.: Rupr. Mem. Ac. Petersb. 6 ser. IX, 2 (1855), t. 1 et 2, fig. 5–16.

Perennial; stem 2–5 cm long; leaves to 1–2 m long, 2–4 mm broad, 3-nerved, coriaceous, flat even in upper part, the sheaths 5–25 cm long; female plants with only 1 or 2 spadices, these borne on a short thick stalk; spathe 3.5–5 cm with a lower dilated portion 3.5–5 cm long and a leaflike
269 upper portion; inflorescence 3 mm broad; bracts oblong-ovate, acute, 5–6 mm long; carpels 15–20, oblong-cordate.

In sea water close to the shore. — Far East: Sakh. (Pil'vo). **Gen. distr.**: N. Am., Japan. Described from California (Columbia River).

Family XIX. **NAJADACEAE** BENTH. et HOOK f. *

Flowers diclinous; plants monoecious or dioecious. Staminate flowers consist of 1 segment, bilobate at tip, often bearing a spathe; anther subsessile, 4- or sometimes 1-loculed. Pistillate flowers with a spathe or more often without one; ovary 1-loculed, with 1 basal erect anatropous ovule; style cylindric, stigmas 2-3. Fruit half covered by leaf sheath; its wall thinner, closely adjacent to seed. Seed hard, with testa smooth or areolate; embryo straight, well developed; endosperm absent. — Only 1 genus.

Genus 54. **NAJAS** L.
L. Gen. pl. ed. 5 (1754) 445.

Annual aquatic plants; leaves linear, opposite or verticillate, with a short and rather narrow sheath at base, sinuate-dentate or serrate, with 2 small intravaginal scales; flowers from the axils of branches, solitary or in groups of several enclosed by leaf sheaths, small, green or reddish.

Fossils of some contemporary and extinct species are known from the Postpliocene. The latter include *N. prisca* Sukacz. — in U. V. (Likhvin); *N. marina* L. — in interglacial formations of U. V. (Borok, Likhvin) and U. Dnp. (Kledovo); *N. minor* All. — in interglacial formations of U. V. (Likhvin); *N. flexilis* (Willd.) Rostk. — in interglacial formations of U. V. (Borok).

1. Dioecious; a vigorous plant, often spiny on the internodes and on the lower leaf surface; pericarp multilayered (Subgenus *Eunajas* Asch.) . . . 1. ***N. marina*** L.
- + Monoecious; a weaker plant; internodes and lower surface of leaves spineless; pericarp thinner, of but 3 layers of indurated cells (Subgenus *Caulinia* (Willd.) Asch.) 2.
2. Leaf sheaths with a short obtuse auricle or exauriculate; staminate flowers inclosed in a spathe; pistillate flowers without spathe 3.
- + Leaf sheaths with a spine-tipped auricle to 2 mm long; staminate and pistillate flowers spatheless (Section *Nudae* Rendle) 6. ***N. graminea*** Del.
3. Sheaths gradually tapering into leaf blade. Seeds smooth (Section *Americanae* Magnus) . . . 2. ***N. flexilis*** (Willd.) Rostk. et Schmidt.
- 270 + Sheaths subtruncate or auricled; seed testa markedly areolate (Section *Euvaginatae* Magnus) 4.
4. Seed testa with rather large square areolae . . . 5. ***N. foveolata*** A. Br.
- + Seed testa with very narrow elongate areolae 5.
5. Seed testa with transversely elongate areolae 3. ***N. minor*** All.
- + Seed testa with vertically elongate areolae . . . 4. ***N. tenuissima*** A. Br.

Subgenus 1. **EUNAJAS** Aschers. Fl. Prov. Brandenb. I (1864) 669. — For characters see the key to species.

1. ***N. marina*** L. Sp. pl. (1753) 1015; Kryl., Fl. Zap. Sib., 116. — *N. major* All. Fl. ped. II (1785) 221; Ldb. Fl. Ross. IV, 20; Shmal'g. II, 538. — *N. monosperma* et *N. tetrasperma* Willd. Sp. pl. IV (1805) 331. — Ic.: Rendle in Trans. Linn. Soc., 2 ser. V (1899), t. 39, fig. 1-30. — Exs.: Herb. Fl. As. Med., No. 414a, b.

* Arranged by S. V. Yuzepchuk.

Annual; a rather vigorous brittle mostly dark green plant; stem 10–60 cm long, more than 1 mm thick; internodes smooth or spiny (especially in upper part of the plant), the lower internodes to 10 cm long; leaves in verticels of 3; sheaths rounded, entire or sparingly denticulate; blades oblong-linear to linear, 1.5–4 cm long, 2–4 mm broad, coarsely sinuate-dentate, often more or less toothed on the back, the teeth varying greatly in length and shape, broad, spreading, spine-tipped; flowers commonly solitary; spathe of staminate flowers with a slightly toothed tip; anthers 4-locular; pistillate flowers not spathaceous; fruit broadly or narrowly ellipsoid, 2.5–8 mm long, 1.5–4.5 mm broad; seed pale yellow to brownish, dull, shortly cuneate at base, wrinkled, the small areolae polygonal. July–September. (Plate XIII, Figure 1 a–b).

Lakes, oxbows, and estuaries. — European part: Lad. -Ilm., U. Dnp., M. Dnp., V. -Don, Transv., Bl., L. Don, L. V.; Caucasus: Cisc., Tal.; W. Siberia: Alt., U. Tob., Irt.; E. Siberia: Ang. -Say.; Far East: Ze. -Bu., Uss.; Centr. Asia: Ar. -Casp., Balkh., T. Sh. (Issyk-Kul'), Kyz. K., Kara K., Syr D. **Gen. distr.**: W. Eur., N. Afr. and African islands, Middle, S. and E. Asia, Australia, N. and S. America. Described from Europe.

Note. A very variable and undoubtedly compound species; its forms in the USSR as yet unexplored. These forms include, for instance, *N. intermedia* Gorski in Eichw. Naturh. Skizze von Lithuan. (1830) 126 — with smooth or almost smooth internodes; the rather thin narrowly linear leaves (1.2–2 mm broad) with 5–7 erect teeth, these equaling or often exceeding the breadth of the blade; the rather small fruit but 3–4 mm long and 1.5–2.5 mm broad; occurring in USSR, e. g., in Lad. -Ilm. (coast of the Gulf of Finland), U. Dnp., M. Dnp. (Kharkov). Described from Lithuania.

Subgenus 2. **CAULINIA** (Willd. pro gen.) Aschers. Fl. Prov. Brandenburg. I (1864) 670. — For characters of the subgenus see the key to species.

Section 1. **AMERICANAE** Magnus in Engl. und Prantl Nat. Pflanzenfam. II, 1 (1889) 217. — Staminate flowers inclosed in a spathe; pistillate flowers without spathe; leaf sheaths recurved.

2. **N. flexilis** (Willd.) Rostk. et Schmidt. Fl. Sedin. (1824) 382. — *Caulinia flexilis* Willd. Mem. Ac. Berl. 1798 (1801) 89. — *C. fragilis* Ldb. Fl. Ross. IV, 19 pro parte. — *N. canadensis* Michx. Fl. Bor. -Amer. II (1803) 220. — Ic.: Rendle in Trans. Linn. Soc. 2 ser. V (1899) 403, t. 40, fig. 92–98. — Exs.: Fr. Herb. norm. XIV, No. 77.

Annual; rather delicate but firm light green plants; stem 8–40 cm long, usually less than 1 mm thick, often subfiliform, the lower internodes to 5 cm long; leaf sheaths gradually tapering to blade, finely denticulate; leaf blade narrowly linear, commonly straight, 1–3 cm long, not more than 1 mm broad, point-tipped, the margin beset with numerous 1-celled spinules; neck of staminate spathe toothed at apex; anthers 1-locular; fruit narrowly ellipsoid, narrowed to both ends, ca. 2–3 mm long and 0.5–1 mm broad; seed yellowish to light brownish, lustrous, smooth, the minute areolae visible only under strong magnification. July–August. (Plate XIII, Figure 2 a–c).

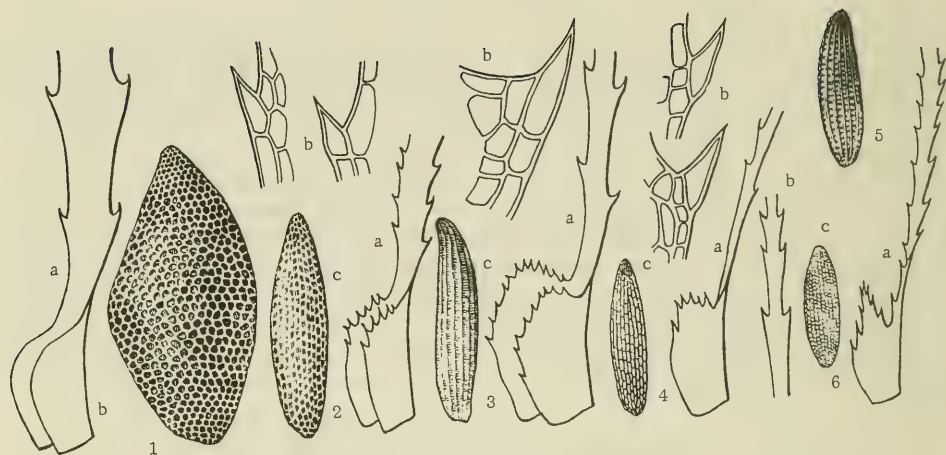


PLATE XIII

1. *Najas marina* L.: a) leaf base; b) seed.— 2. *N. flexilis* Rostk.: a) leaf base; b) leaf teeth; c) seed.— 3. *N. minor* All.: a) leaf base; b) leaf tooth; c) seed.— 4. *N. tenuissima* A.Br.: a) leaf base; b) leaf teeth; c) seed.— 5. *N. foveolata* A.Br.: seed.— 6. *N. graminea* Del.: a) leaf base; b) middle portion of leaf; c) seed.

Lakes. — European part: Kar. -Lap., Lad. -Ilm., U. Dnp.; W. Siberia: Alt. (Naryn Territory). **Gen. distr.:** Scand., Centr. Eur., N. Am. Described from N. America (Pennsylvania). Type in Berlin.

Section 2. **EUVAGINATAE** Magnus in Engl. und Prantl. Nat. Pflanzenfam. II, 1 (1889) 218. Staminate flowers inclosed in a spathe; pistillate flowers without spathe; leaf sheaths subtruncate or auriculate.

3. **N. minor** All. Fl. pedem. II (1785) 221; Kryl., Fl. Zap. Sib. I, 117. — *Caulinia fragilis* Willd. in Mem. Acad. Berlin 1798 (1801) 88; Ldb. Fl. Ross. IV, 19. — Ic.: Rendle in Transact. Linn. Soc. 2, Ser. V; (1899), t. 41, fig. 105—115. — Exs.: HFR, No. 392.

274 Annual, weak and brittle (especially in dry state), dark green; stem 4—25 cm long, not more than 1 mm thick, often filiform, much branched (often dichotomously), the lower internodes not more than 5 cm long; leaves with rounded subtruncate spinulose-toothed sheath, narrowly linear, 1—2 cm long, to 0.5 mm broad or slightly broader, attenuate toward apex, mostly recurved, each margin with 6—10 spreading, rather large, mostly many-celled teeth (these often equaling the breadth of the blade), broad at base, terminating in a 1-celled mucro; spathe of staminate flowers prolonged into a beak, this toothed at the tip; anthers 1-locular; fruit oblong-linear, 2—3 mm long, ca. 0.5 mm broad; seed dark-colored, the transversely elongate areolae in 12—18 rows. July—April [?]. (Plate XIII, Figure 3 a—c).

Oxbows, lakes, and canals. — European part: M. Dnp., V. -Don, Transv., Bl., L. Don, L. V.; Caucasus: Cisc. (Kuban District), W. Transc., E. Transc., Tal.; W. Siberia: Irt.; Far East: Ze. -Bu., Uss.; Centr. Asia: Balkh., Kyz. K. (delta of Amu Darya). **Gen. distr.:** Centr. and S. Eur., Afr., Hither Asia, S. and E. Asia. Described from Italy (Piedmont).

4. **N. tenuissima** A. Br. ex Magnus, Beitr. Najas (1870) 24, 45. — Ic.: Magnus, l. c., 5 fig. 13, 14. — Exs.: Pl. Finl., No. 438.

Annual, very delicate, soft, dark green; stem 8—20 cm long, slender, often filiform, branched; leaf sheath truncate or auriculate enlarged at apex, with hairlike teeth on the margin; leaf blade linear, very narrow, 1—2 cm long, slightly recurved or suberect, each margin with 8—10 very small usually 3-celled teeth; spathe of staminate flowers beaked at apex, the beak long and pointed, 2.5 mm long, 2-toothed at tip; anthers 1-locular; fruit narrowly ellipsoid, ca. 0.5 mm broad; seed lustrous, brownish, the rectangular areolae vertically elongate. July—August. (Plate XIII, Figure 4 a—c).

Lakes. A very rare plant, known from few locations. — European part: Lad. -Ilm. (Valdai District, Lake Bologoe, Piroso; Vyshnii Volochek District, Lake Kolomno). **Gen. distr.:** S. Finland. Described from Finland.

5. **N. foveolata** A. Br. ex Magnus, Beitr. Najas (1870) VII. Ic.: Rendle in Trans. Linn. Soc. 2, Ser. V (1899), t. 41, fig. 139—144.

Annual, delicate, rather brittle, gramineous-green; stem 16—20 cm long, slender, much branched (especially in upper part), the lower internodes 3—4 cm long; leaves linear, thin, 1.5—3.5 cm long, ca. 1 mm broad, the upper ones often very narrow, the margin with 6—20 small erect few-celled spinulose teeth; leaf sheaths with very short rounded auricles and few teeth at apex; spathe of staminate flowers elliptic, terminating in a cylindric beak;

275 fruit 2—2.50 mm long; seed with 20 rows of very conspicuous, rather large, square, distinctly concave areolae. (Plate XIII, Figure 5).

Lakes and lakelets. — Far East: Uss. (Lake Khanka, Suifun River).

Gen. distr.: S. Asia (East Indies, Philippines, etc.), Japan. Described from India.

Note. Identification of the Ussuri plant with the authentic *N. foveolata* A. Br. needs confirmation.

Section 3. **NUDAE** Rendle in Trans. Linn. Soc. 2, Ser. V (1899) 424. — Staminate and pistillate flowers without spathe; leaf sheaths with spine-tipped auricles.

6. **N. graminea** Del. Fl. Egypte (1812) 282. — *N. alagnensis* Poll. Fl. veron. III (1824) 49. — *N. seminuda* Grif. in Voigt, Hort. suburb. Calcutt. (1845) 694. — **lc.:** Baley in Journ. Bot. XXII (1884), t. 250; Rendle in Trans. Linn. Soc. 2, ser. V (1899), t. 192—201. — **Exs.:** HFR, No. 2447.

Annual, delicate, not brittle, gramineous-green; stem 20—50 cm long, usually not more than 1 mm thick, with short densely leafy branches; leaf sheaths prolonged on each side of the leaf into a very slender linear auriclelike denticulate point ca. 2 mm long; leaf blade narrowly linear, 1.5—4 cm long, straight, flexible, with 30—50 very small and slender 1—3-celled teeth; anthers 4-locular; fruit oblong-ellipsoid to subcylindric, 1—2 cm long, finely areolate, the usually square areolae in 20—30 rows. June—September. (Plate XIII, Figure 6 a—c).

Lakelets (outside the USSR often in ricefields). — Centr. Asia: Kara-Kum (Chardzhou). **Gen. distr.:** S. Eur., Atl. Eur. (England), N. Afr., S. and E. Asia, Australia. Described from Egypt.

Note. Beside the forms (or races) of this apparently compound species, accounted for in synonymy, *N. serristipula* Maxim. in Bull. Acad. St. Petersb. XII (1868) 72, also belongs here; it is recorded in the literature, probably erroneously, for the Ussuri area.

Family XX. **JUNCAGINACEAE** LINDL.

Annual or perennial glabrous herbs, mostly paludal; leaves 2-ranked, mostly radical, linear, sheathing at base and ligulate; inflorescence terminal, spikelike or paniculate, mostly bearing terminal flowers; flowers small, greenish, perfect, regular; perianth biseriate, mostly of 6 segments; stamens 276 commonly 6, with short filaments; anthers with 2 pollen sacs; pistils 6; distinct or cohering, each 1- or rarely 2-ovuled; style usually wanting; stigma with long papillae; fruit dry, consisting of more or less united carpels or separating into carpels along a central axis, 1- or 2-seeded; seed exalbuminous.

- 1. Stem leafy; carpels united only at base 56. **Scheuchzeria** L.
- + Stem leafless; all leaves radical; carpels united throughout their length 55. **Triglochin** L.

* Arranged by B. A. Fedchenko.

Genus 55. **TRIGLOCHIN** L.*

L. Gen. ed. 1 (1737) 176.

Leaves radical, narrowly linear or subulate; inflorescence terminal, spikelike; flowers perfect, inconspicuous; perianth segments 6; stamens 6; sometimes partly rudimentary; anthers sessile, dorsifixed, extrorse; pistil of 6 carpels, these united (with USSR species), at length separating, of these mostly only the three inner ones containing 1 ovule, the three outer ones sterile.

1. Fertile carpels 6; fruit ovoid-oblong 1. **T. maritima** L.
- + Fertile carpels 3; fruit linear 2. **T. palustris** L.

1. **T. maritima** L. Sp. pl. (1753) 339; Ldb. Fl. Ross. IV, 35. — *T. Roegneri* C. Koch in *Linnaea* XXXII (1849) 567. — *T. Ani* C. Koch *ibid.*, 273; Ldb. Fl. Ross. IV, 36. — *T. transcaucasica* Bordzil. in *Trud. Yur'ev. Bot. sada*, XIII (1912) 13. — *lc.*: Fl. Dan. II, t. 306; Rchb. *lc. fl. germ.* VII, t. 52. — *Exs.*: Fl. Austr.-Hung., No. 3919; Fl. exs. boh. slov., No. 288; Rchb. Fl. Germ., No. 165, 890; HFR, No. 237.

Perennial, rootstock vertical or oblique, strong, covered with sheaths of old leaves; a lower form, more densely covered with roots and scales, is known from the Caucasus and bears the name *var. deserticola* Buchen.; stems erect, 10–80 cm long, terete, stout; leaves shorter than stem, semiterete, scarcely channeled toward apex, to 4 mm broad, the ligule long; inflorescence a rather dense many-flowered raceme; pedicels to 4 mm long; outer perianth segments broadly ovate, the inner ones narrower; pistils 6; fruit borne on a divergent stalk, ovoid, rarely subglobose (*var. transcaucasica* Bordzil.), 6-angled; carpels 6, separating from the fruit axis, grooved on the back. May–August. (Plate X, Figure 5 a–d).

Northern seashores, sphagnum bogs in the forest zone, and solonchak meadows in the south. — Arctic: Arc. Eur.; European part: Kar.-Lap., 277 Dv.-Pech., Lad.-Ilm., U. V., V.-Kama, M. Dnp., V.-Don, Transv., Bl., L. V., L. Don, Crim.; Caucasus: Cisc., E. Transc., W. Transc.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen., Lena-Kol., Ang.-Say., Dau.; Far East: Uda, Uss., Sakh.; Centr. Asia: Ar.-Casp., Balkh., Pam.-Al., T. Sh. **Gen. distr.**: Scand., Atl. and Centr. Eur., Med., Bal.-As. Min., Mong., N. and S. Am. Described from Europe.

Economic importance. This plant provides fairly good forage and it occurs on extremely poor solonchak soils. The young foliage is used in some localities for food, though in cooking it emits an unpleasant odor characteristic of all arrow-grass species. Upon combustion the plant yields ash rich in sodium carbonate that is used in soap production.

2. **T. palustris** L. Sp. pl. (1753) 338; Ldb. Fl. Ross. IV, 35. — *lc.*: Fl. Dan., III, t. 490; Rchb. Fl. germ. VII, t. 51. — *Exs.*: Tausch, *Herb. Boh.*, No. 1550; Rchb., Fl. germ. No. 164; HFR, No. 186.

Perennial; rootstock short, emitting in fall slender brittle bulb-bearing stolons; stems 10–50 cm long, erect; leaves erect, semiterete below, terete above, rarely flat (*var. uzonica* Kom.), shorter than stem, short-ligulate; inflorescence a rather loose many-flowered raceme; pedicels 1–4 mm long; flowers small, ca. 3 mm long; perianth segments broadly ovate; pistils 3;

* From Greek *triglochin*, three teeth or three points.

fruit linear, appressed to stem, up to 8 mm long, separating in maturity into 3 carpels. June—August. (Plate X, Figure 6 a—c).

Wet meadows, bogs, sometimes alkaline, and river banks. — European part: all regions; Caucasus: Cisc., Dag., W. Transc., E. Transc., S. Transc.; W. Siberia: all regions; E. Siberia: all regions; Far East: all regions; Centr. Asia: Ar. -Casp., Balkh., Dzu. -Tarb., Kara K., Syr D., Amu D., Pam. -Al., T. Sh. **Gen. distr.:** Scand., Centr. Eur., Atl. Eur., Med. (?), Dzu. -Kash., Mong., Jap. -Ch., N. Am. (Chile) [sic]. Described from Europe. Type in London.

Economic importance. A fairly good forage plant, readily eaten by cattle, sheep, and camels. The fruits, mixed with flour, are fed in some localities to domestic geese and ducks.

Genus 56. **SCHEUCHZERIA** L.

L. Gen. pl. ed. 1 (1737) 106.

Perennials; stem leafy all the way up; inflorescence a few-flowered raceme; perianth of 6 segments in 2 series; stamens 6, the filaments filiform at the ends; anthers linear, basifixed, finally pendulous; carpels 3—6, each containing 2 ovules; style none; stigma papillose on the outer
278 surface at the top of the carpel; fruits commonly 3, spreading, 1- or 2-seeded.

Fossils of the extant genus *Scheuchzeria* are known in the USSR, namely *S. palustris* L. in interglacial formations of U.Dnp. (Murava).

1. *S. palustris* L. Sp. pl. (1753) 338; Ldb. Fl. Ross. IV, 37. — Ic.: Fl. Dan. I, tab. 76; Rchb. Ic. fl. Germ. X, t. 419. — Exs.: Fl. Hung., No. 399; Hayek Fl. stir. exs., No. 712; Rchb. Fl. exc., No. 548; Schultz. Fl. Gall. et Germ. exs. 4. Cent., No. 42; HFR, No. 440.

Perennial; rootstock short, emitting stolons to 50 cm long; stems 15—25 cm long; radical leaves erect, to 25 cm long; cauline leaves 2 or 3, equaling or exceeding the stem; leaves sheathing at base, with an elongate ligule, the narrowly linear blade somewhat channeled; inflorescence slightly branched; pedicels to 25 mm long; flowers to 3 mm long; perianth segments lanceolate, acute, greenish; carpels 1—6, mostly 3. May—July. (Plate X, Figure 8 a—b).

Wet places in sphagnum bogs, forming so-called "scheuchzerieta." — European part: Kar. -Lap., Dv. -Pech., Lad. -Ilm., U. V., V. -Kama, V. -Don, Transv.; Caucasus: reported without specification of location; W. Siberia: Ob, U. Tob., Alt.; E. Siberia: Yen., Lena-Kol., Ang. -Say., Dau.; Far East: Kamch., Ze. -Bu., Uda, Uss., Sakh. **Gen. distr.:** Scand., Atl. Eur., Med., Jap. LCh., N. Am. Described from several places — Lapland, Switzerland, Sweden, Prussia. Type in London.

Family XXI. **ALISMATACEAE** (ALISMACEAE) DC.

Flowers perfect or unisexual, actinomorphic, with 3-merous calyx and corolla; stamens 6 to many; pistils 6 to many, distinct or rarely cohering at base (in *Damasonium*), 1-locular, with 1 to many anatropous ovules;

* Arranged by S. V. Yuzepchuk.

fruits in heads; the pericarp leathery or its inner part woody; seeds without endosperm; embryo horseshoe-shaped. Aquatic or paludal plants with a short rootstock, a rosette of variously shaped radical leaves; stem [scape] commonly destitute of green leaves, often branched.

1. Flowers unisexual; stamens many; receptacle convex; fruits spirally arranged in heads 61. **Sagittaria** L.
- + Flowers perfect; stamens 6; fruits arranged in a circle 2.
2. Carpels containing 2 or more ovules; receptacle elongating in fruit into a column, the carpels spreading stellately. 60. **Damasonium** Juss.
- 279 + Carpels containing 1 ovule; receptacle remaining flat in fruit, the ripe carpels not changing their position; fruit a head, not stellate 3.
3. Fruitlets [achenes] many, strongly compressed laterally, the beak attached ventrally at the middle or in the upper part 57. **Alisma** L.
- + Fruitlets 6—9 (rarely up to 12), not compressed or scarcely compressed, the beak terminal. 4.
4. Leaves cordate at base; fruitlets obliquely obovoid, the style recurved toward the ventral margin, dorsal ridges few, the pericarp strongly lignified 58. **Caldesia** Parl.
- + Leaves rounded at base; fruitlets ovoid, with terminal style and numerous ridges all over the surface, the pericarp not lignified 59. **Elisma** Buchen.

Genus 57. **ALISMA** L.

L. Gen. pl. ed.I (1737) 108.

Flowers perfect; sepals 3, persistent in fruit; petals 3, very thin; stamens 6; anthers ventrifixed above the base, dehiscing by lateral slits; receptacle scarcely convex; pistils many (mostly about 20), arranged in a circle, the style arising ventrally below the apex; ovary 1-ovuled, the ovule facing outward; carpels free, strongly compressed laterally and tightly appressed to each other, forming a spherical or irregularly 3-angled head; pericarp thin, papery. Perennials with leaves in a radical rosette and mostly a large verticillately branched paniculate inflorescence.

The only genus known in the USSR in fossilized condition is *Alisma*. Beside *A. Loeselli* from Quaternary formation of L. Don (Archada woodland), *Alisma* sp. was found in Tertiary formations (Oligocene?) of Balkh. (Ashutas).

1. Style more or less straight, as long as ovary, its vestige borne on the almost straight ventral margin of the carpel; plants not forming an aquatic form, always developing aerial leaves differentiated into petiole and blade (Cycle *Plantago-aquatica* Juz.) 2.
- + Style hooked, shorter than ovary, its vestige borne at the middle of the convex ventral margin of the carpel; plants occurring in two forms: aquatic, with submersed straplike leaves, and terrestrial with petiolate aerial leaves (Cycle *Graminea* Juz.) 4.
2. Leaves plain green, ovate or broadly ovate, rounded or subcordate at base; petals round-tipped 3.
- 280 + Leaves glaucescent, lanceolate to broadly lanceolate, cuneately narrowed at base; petals pointed at apex 3. **A. lanceolatum** With.

3. Flowers ca. 1 cm in diameter; carpels commonly 2—3 mm long 1. **A. plantago-aquatica** L. s. str.
- + Flowers ca. 6 mm in diameter; carpels 1.5—2 mm long 2. **A. orientale** (G. Sam.) Juz.
4. Stem of the terrestrial form longer than leaves, erect; leaves of the aquatic form 3—15 mm broad 4. **A. Loeselii** Gorski.
- + Stem of the terrestrial form as long as or shorter than leaves, ascending or prostrate; leaves of the aquatic form 1—2 mm broad 5. **A. Wahlenbergii** Holmb.

Cycle 1. *Plantago-aquatica* Juz. nov. Terrestrial plants; style straight, long; carpels mostly with an almost straight ventral margin, beaked from about its middle.

1. **A. plantago-aquatica** L. Sp. pl. (1753) 343 s. str.; Ldb. Fl. Ross. IV, 39 pro max. p. — *A. latifolium* Gilib. Fl. lith. V (1781) 222. — *A. majus* (major) S. F. Gray Nat. Arr. Brit. Pl. II (1821) 216. — *A. Michaletii* Asch. u. Gr. Fl. Nordostdeutsch. Flachl. (1898) 65. — *A. plantago* var. *latifolium* Kunth Fl. Berl. II (1838) 295; Kryl., Fl. Zap. Sib. I, 122. — Ic.: Rchb. Ic. Fl. Germ. VII (1843), t. 57. — Exs.: Pl. Finl., No. 35. —

Perennial; rootstock stout (to 2 cm thick, usually broader than long), tuberous; stems 10—70 cm long, erect, straight, branched only in upper part; leaves plain green, only the basal ones sessile, broadly linear, floating, the others emersed, long-petioled, the large blade ovate to broadly ovate, commonly cordate or subcordate or rarely rounded at base, subacute or acute at apex; inflorescence large, paniculate, pyramidal, gradually narrowed upward, of 5 or 6 (—10) subapproximate whorls, usually with 6—9 (—10) branches per whorl, the branches and pedicels erect to spreading, more or less straight; bracts lanceolate, acuminate; pedicels commonly ca. 2 mm long, slender; sepals ca. 3 mm long, 2 mm broad, ovate or broadly ovate, mostly acutish, green; petals twice as long as sepals, evanescent, white or on the back pale pink, with yellow claw, rounded at apex; stamens twice as long as pistils; anthers oblong, yellow; pistils not reaching the middle of the flower, leaving a free space at center; style straight, 1—1.25 mm long, longer than ovary, arising about the middle; fruiting head irregularly 3-angled; carpels 2—3 mm long, obliquely obovoid, dorsally convex and mostly shallowly 1-grooved, the ventral margin almost straight or slightly convex. June—August. (Plate XIV, Figure 1 a—c).

281 River banks, lakes, ponds, canals, and bogs. European part: everywhere except the Arctic region; Caucasus: all regions; Siberia: all regions except Arc. and Uss.; Centr. Asia: all regions (unknown from Kara K. and Mtn. Turkm.). **Gen. distr.:** in north of Temperate Zone of Eurasia. Described from Europe.

Economic importance. A powder prepared from dried roots is used in popular medicine as a cure for rabies and crushed leaves are used against mammary congestion; fresh leaves are employed in homeopathy. Harmful to stock, but the toxic properties disappear in drying. The rootstocks contain starch and are edible (roasted in ashes they are eaten by Kalmucks). Since this species is often confounded or identified with others of the genus, the reported data may also refer to the next two species.

2. **A. orientale** (G. Sam.) Juz. comb. nova. — *A. plantago-aquatica* var. *orientale* G. Sam. in Meddel. Göteb. Bot. Trädg. II (1926) 84. — *A. p.-a.* subsp. *orientale* G. Sam. in Ark. f. Bot. 24 A (1932), No. 7, 16. — *A. p.* var. *parviflorum* auctt. fl. japon. non Torr. — Ic.: Somoku Dzusetzu II, 7 (1910), t. 33. —

Perennial; leaves subcordate, rounded or sometimes angular at base; inflorescence often much branched, very many-flowered, the lower branches elongated, many-whorled; pedicels commonly 1–1.5 cm long; flowers much smaller than in *A. plantago-aquatica*, 6–8 mm in diameter; sepals to 2 mm long, ca. 1.5 mm broad, broadly ovate to suborbicular, commonly obtuse; petals ca. 3–4 mm long; styles 0.4–0.6 mm long, somewhat curved; carpels 1.5–2 mm long.

Far East: Uss. **Gen. distr.**: Japan, Mongolia, China, Himalayas. Described from Japan. Type in Leningrad.

Note. Some specimens of *A. plantago-aquatica* from the S. regions of Centr. Asia apparently gravitate toward this race; it is possible that it may prove to be a widespread South Asian form.

3. **A. lanceolatum** Wither. Bot. Arang. Brit. Plants Ed. 3, II (1796) 262. — *A. stenophyllum* G. Sam. in Sv. Bot. Tidskr. Bd. 16 (1922) 39. — *A. Michaletii* B. *stenophyllum* Asch. et Gr. Syn. I (1897) 393. — Kryl., Fl. Zap. Sib. I, 122. — *A. plantago* var. *lanceolatum* auct. plur.; Ldb. Fl. Ross. IV, 40 pro parte. — *A. plantago* var. *angustifolium* Ldb., l. c., pro parte. — Ic.: H. Glück, Unters. üb. Wasser- u. Sumpfgew., Vol. 1 (1905), tab. fig. 2 a–c. — Exs.: Fl. austrohung. 3916.

Perennial; leaves glaucescent, the petiole as long as or longer than the blade, this narrowly to broadly lanceolate, cuneately narrowed at base; inflorescence of medium size, moderately branched, the branches rather spreading; pistil nearly reaching the middle of the flower; style fairly straight, somewhat longer than ovary. In other characters resembling *A. plantago-aquatica*. June to fall. (Plate XIV, Figure 2).

282 In the same habitats as *A. plantago-aquatica*, but much less frequent. European part: Lad.-Ilm., U. V., V.-Kama, U. Dnp., M. Dnp., Bl., V.-Don, Transv., L. V., Crim.; Centr. Asia: Balkh., Syr D., Pam.-Al. **Gen. distr.**: W. Eur., Hither Asia. Described from England.

Cycle 2. **Graminea** Juz. nov. Plants producing terrestrial and aquatic forms; style hooked, short; fruit convex on the ventral margin, with a remnant of style (beak) near its apex.

4. **A. Loeselli** Gorski in Eichw. Nat. Skizze Lith. (1830) 127 (nomen; descr. et ic. apud Loesel. Fl. pruss. (1703), tab. 62 sub nom. *Plantago aquatica leptomacrophyllos*). — *A. arcuatum* Michal. Bull. Soc. bot. France I (1854) 312; Kryl., Fl. Zap. Sib. I, 122. — *A. gramineum* auct. mult., vix autem. — *A. graminea* C. Chr. Gmelin Fl. Badens. Als., t. IV (1826) 256. — *A. plantago* β *angustifolium* Ldb. Fl. Ross. IV, 40 pro parte. — *A. plantago* γ *graminifolium* Ldb. Fl. Ross. IV, 40 pro maxima parte. — Ic.: Glück. Biol. u. Morph. Wass. u. Sumpfgew. I., t. 1 (1905); Samuels. in Ark. f. Bot. 24 A, No. 7, taf. 4, 5. — Exs.: HFR, No. 1189, 2534, 2540.

Perennial; rootstock moderately stout, oblong (longer than broad); stems 10–30 (–60) cm long, often ascending at base, then erect, branching also in lower half, longer than leaves; leaves in aquatic (typical) form all sessile, linear, floating, to 1 m long, 3–10 (–15) mm broad, in terrestrial forms (*A. arcuatum* Michalet) short-petioled, oblong-elliptic, lanceolate, or linear-lanceolate, narrowed to both ends, glaucescent; inflorescence moderately long, abruptly narrowed toward apex, with few, often 2 or 3 remote whorls and 10–12 branches in each whorl, the lower branches very long; branches and pedicels often horizontally spreading or even recurved; pedicels rather stout; petals half as long again as sepals, rather persistent, often reddish; stamens as long as pistils; anthers round; pistils closely contiguous on ventral side, filling the whole space at center; style shorter than ovary, arising at its apex, hamately recurved; fruiting head regularly triangular or nearly round in outline; carpels commonly with 2 dorsal ridges and 3 distinct keels, the ventral margin curved at an angle. July–August. (Plate XIV, Figure 3 a–c).

Shores, canals, bogs, and wet meadows, often in saline soil. — European part: Lad.-Ilm. (Pskov), U. V. (Rybinsk), V.-Kama, U. Dnp., M.-Dnp., V.-Don, Transv., Bl., L. Don, L. V.; Caucasus: Cisc., E. Transc., Tal.; Central Asia: everywhere (unknown in Kara K. and Mtn. Turkm.); W. Siberia: Ob, Irt., Alt.; E. Siberia: Yen., Ang.-Say., Dau. **Gen. distr.:** W. Eur., N. Afr., As. Min., Mong. Described from Prussia.

5. **A. Wahlenbergii** Holmb. ap. Samuels., Sv. Bot. Tidskr. 16 (1922), 41. — *A. gramineum* subsp. *Wahlenbergii* Holmb. in Bot. Notis. (1922), 207. — *A. plantago* β *graminifolia* Wahlenb. Fl. Ups. (1820) 122; Ldb. Fl. Ross. IV, 40 in citation from Wahlenberg. — Annon. *A. gramineum* C. Chr. Gmel. Fl. Badens. Als., t. IV (1826) 256? (nomen prius). — Ic.: Samuels. in Ark. f. Bot. Bd. 24 A, No. 7, taf. 6.

Perennial, smaller and weaker than *A. Loeselii*; stems 3–20 cm long, in aquatic (typical) form half as long, in terrestrial form (*f. emersum* Holmb.) about as long as the leaves, rather numerous, rarely solitary, ascending or prostrate; leaves in aquatic form sessile, narrowly lorate, 10–40 cm long, 1–2 (–3) mm broad, in terrestrial form long-petioled, narrowly oblong-lanceolate, 2–5 cm long, 3–8 mm broad; peduncle and inflorescence short, the inflorescence of 1–3 whorls; in aquatic form the flowers cleistogamous (flowering in water); carpels smaller than those of *A. Loeselii*, nearly round. July–August.

Lakes and their shores, also seashores. — European part: Lad.-Ilm. (Kronstadt and Petergof [Petrodvorets]), U. V. (Lake Seliger). **Gen. distr.:** Scand. (the nearest known location in Nyland County [Uusimaa] in S. Finland). Described from Sweden.

Note. When it is finally established that the characters apply to the authentic *A. gramineum* C. C. Gmel., this name will probably have to be retained for this species which is, however, somewhat critical and in need of experimental study.

Genus 58. **CALDESIA** PARL.

Parl. Nuov. gen. e spec. Monocot. (1854) 57.

Flowers perfect; sepals 3; petals 3; stamens 6 (in our species), rarely 11; anthers basifixed, dehiscing by a longitudinal slit; pistils 6–9, arranged in a

circle, the style arising ventrally at apex, slender, often persistent; ovary 1-locular, the embryo basal; fruit drupaceous, with spongy outer and woody inner coat, 1-seeded. Perennials resembling in aspect species of *Alisma*. Fruits set rarely in USSR form (plants reproducing mostly by means of winter-buds).

1. *C. parnassiifolia* (Bassi) Parl. Nuov. gen. e spec. Monocot. (1854) 57. — *Alisma parnassifolium* Bassi in L. Syst. nat. ed. 12, III (1768) 230; Ldb. Fl. Ross. IV, 40. — *A. dubium* Willd. Fl. Berol. (1787) 132. — Ic.: Rchb. Ic. Fl. Germ. VII (1845), t. 56. — Exs.: HFR, No. 2538.

284 Perennial; rhizome slender, very short; leaf petiole ca. 5 cm long in terrestrial forms, up to 20 cm or even longer in aquatic forms with floating leaves (*A. dubium* Willd.); leaf blade 1–3 cm long, 0.8–2.5 cm broad, in aquatic forms to 5 cm long and 3.5 cm broad, ovate, cordate at base, narrowed toward apex, subacute to subobtuse, 5–11-nerved; stem 10–50 (–70) cm long, longer than leaves; inflorescence verticillately racemose or paniculate, commonly with 3 branches in each whorl, all the branches or merely the upper ones 1-flowered; pedicels 1–3 cm long, stoutish, strongly thickened toward the end; sepals ca. 3 mm long, rounded at apex; petals barely longer than sepals, broadly ovate, white; stamens 6; fruits 8–10, more than 2 mm long, obliquely obovoid, narrowed toward base, convex on the back, ca. 1 mm broad, with 3 prominent nerves, the ventral margin straight, prolonged into a straight beak half as long as the body; fruits do not usually develop in the USSR (the plants reproduce by means of winter buds developing in the axils of scalelike upper leaves, these borne in whorls of 3 on separate stems resembling the floriferous but abbreviated and usually prostrate). July–August. (Plate XIV, Figure 4 a–b).

Lakelets, ponds, and bogs. — European part: U. Dnp., M. Dnp., V. -Don; Far East: Uss. **Gen. distr.:** Centr. and S. Eur., Egypt (typical form); Manchuria and apparently also China and Japan (Far Eastern race, see note*). Described from the Apennines.

Note. Plants from Uss. differ from the European in having round-tipped obtuse leaves; pedicels longer (to 5 cm), slender, less conspicuously thickened upward. These plants constitute apparently a distinct race somewhat resembling the tropical *C. reniformis* (D. Don) Makin. The problem needs additional study.

Genus 59. **ELISMA** BUCHEN.

Buchen. in Pringsh. Jahrb. VII (1868) 19, t. 2.

Flowers perfect; sepals 3, herbaceous, persistent in fruit; petals 3, much larger than sepals, very thin; stamens 6; anthers dehiscent by a longitudinal slit; receptacle low; pistils 6–9 (very rarely 10), arranged in an irregular circle, with a terminal style; ovary 1-ovuled, the ovule turned inward; fruits ovoid, not flattened, grooved, in irregularly shaped heads. Only 1 species.

1. *E. natans* (L.) Buchen., l. c., 20. — *Alisma natans* L. sp. pl. (1753), 343; Ldb. Fl. Ross. IV, 40 (beside citations from Pallas for Novgorod). — Ic.: Rchb. Iconogr. bot. I (1823), t. 37.

* The Japanese, however, designate their plant as *C. reniformis* (D. Don) Mak.

Perennial; stem trailing or floating, rooting at nodes; lower leaves 5–6 cm long, 2–3 mm broad, linear; upper leaves long-petioled, the ovate 3-nerved blade to 3 cm long; stem 10–40 cm long; bracts often leaflike, floating, long-petioled, with ovate or orbicular blade to 1 cm long; flowers long-pedicelled; sepals to 3 mm long, green, with a broad scarious margin; petals to 1 cm long, round, white, with a yellow spot at base; anthers yellow; 285 fruit oblong-ovoid, with 12–15 grooves, the small terminal point representing a remnant of the style. Fl. throughout summer.

Lakes, ponds, bogs, and canals. — European part: Bes. Gen. distr.: Centr. and Atl. Eur. (absent from Med.). Described from France and Sweden.

Genus 60. **DAMASONIUM** * JUSS.
Juss. Gen. (1789) 46.

Flowers perfect; stamens 6, the filaments flattened; pistils 6–9, with 2 to many ovules and a terminal style; fruit stellate, of 6–10 carpels, these spreading, with coriaceous pericarp, terminating in the persistent style forming a long beak and finally separating from the columnar central axis (the accrescent receptacle); seed curved, the testa transversely crested. Perennials, resembling *Alisma* in aspect, but with less ample inflorescence.

- 1. Carpels gradually tapering into the beak, the dorsal margin straight . . . 1. **D. alisma** Mill.
- + Carpels abruptly narrowed into the beak, the dorsal margin curved at an obtuse angle . . . 2. **D. constrictum** Juz.

1. **D. alisma** Mill. Dict. II (1768) 3. — *D. stellatum* Rich. in Pers. Syn. I (1805) 400; Ldb. Fl. Ross. IV, 42 (beside citations from Pallas and Stefan for Moscow). — *Alisma Damasonium* L. Sp. pl. (1753), 343. — Ic.: Glück Biol. u. Morph. Wass. u. Sumpfgew. I (1905), t. V, fig. 32.

Perennial; rootstock to 2 cm long, stout; leaves partly rosulate and partly borne on petioles to 25 cm long; blade elongate-ovate or rarely lanceolate, 1–6 (–7) cm long, 0.3–0.5 cm broad, rounded or subcordate at base, obtuse or rarely subacute, 3- or rarely 5-nerved; stem 5–30 cm long, commonly erect, rarely arched-ascending at base, simple or branched near the top; inflorescence an umbel or compound panicle; bracts ca. 5 mm long; flowers 5–10 or more in each whorl; pedicels 1–3 cm long, stoutish, erect, rarely spreading; sepals broadly ovate, ca. 2 mm long, green, scarious-margined; petals at least twice as long as the sepals, broad, white, yellow at base; stamens short, caducous; carpels 6–10 (commonly 7–8) mm long, at base (sideways) 2–3 mm broad, terminating in a long hooklike-recurved beak, the back straight (beak not divergent), barely longer than the ventral (upper) margin, the carpel, as seen from the back, gradually attenuate upward and passing into the beak; seeds commonly 2, ca. 1.5 mm long. May–June. (Plate XIV, Figure 5).

286 Muddy, boggy places, especially margins of ponds, and canals. — European part: Bl. (e. g., Askaniya-Nova), reported for L. V.; Caucasus: E. Transc. (Sal'yany); W. Siberia: U. Tob., Irt.; Centr. Asia: Ar. -Casp. Gen. distr.: Atl. Eur., Med., N. Afr. (Egypt). Described from England.

* *Damasonion* — a plant name already mentioned by the Roman writer Pliny.

2. **D. constrictum** Juz. in Acta Inst. Bot. Ac. Sc. USSR I (1933). — *D. alisma*. Kryl., Fl. Zap. Sib. I, 123 (non Mill.).

Perennial, usually smaller and weaker than the preceding; rootstock short, slender; leaf petioles 2.5–20 cm long; blade to 3 cm long and 1.5 cm broad, ovate, narrowly ovate, or lanceolate, commonly 3-nerved, cordate, rounded or cuneate at base, subobtusate or often acuminate; stem 3–25 cm long, erect; flowers 3–8 in a whorl; pedicels 0.7–2.5 (–4) cm long, slender; sepals ovate; carpels 6–8 mm long, at base (from the side) 3–4 mm broad (the height of the central column), curved on the back at an obtuse angle (the beak apparently divergent), the dorsal margin much longer than the ventral (upper) margin, the carpel, as seen from the back, abruptly narrowed about the middle into the beak (appearing inflated in lower part); seeds 7, ca. 1 mm long. In other characters resembling *D. alisma*. May–June. (Plate XIV, Figure 6 a–b).

Shores of lakes and estuaries, wet meadows, lowlands, and river valleys. — European part: L. V.; W. Siberia: U. Tob., Irt.; Centr. Asia: Ar. – Casp. Described from Kazakhstan. Type in Leningrad.

Genus 61. **SAGITTARIA** * L.

L. Gen. pl. ed. 1 (1737) 289.

Flowers commonly unisexual, monoecious; sepals 3, persistent in fruit, often accrescent; petals large, caducous; stamens mostly many, the filaments slender or dilated, the basifixed anthers dehiscent by a lateral slit; anthers in pistillate flowers obsolescent; pistils many, arranged spirally on the receptacle; ovary 1-ovuled; style straight, at length sometimes obliquely or horizontally divergent; fruits strongly flattened, more or less winged. Perennial aquatic or paludal herbs, often with tuberous stolons; submersed leaves ribbon-shaped; floating and emersed leaves mostly sagittate; inflorescence branches and pedicels in whorls of 3.

1. Blade of emersed leaves (when these present) sagittate, lobed at base; filaments of stamens naked; fruits conspicuously beaked (the beak representing a remnant of the style) 2.
- + Blade of emersed leaves oblong, usually narrowed to both ends (without basal lobes); filaments hairy; fruits with a very short beak or beakless; adventive North American plants 4. **S. graminea** Michx.
2. Emerged leaves always present; submersed and floating leaves usually none; lobes much longer than the blade; anthers yellow 2. **S. trifolia** L.
- + Forms with some submersed and floating leaves frequently occurring; lobes as long as or shorter than the blade 3.
3. Lobes of emersed leaves about as long as the blade (rarely somewhat longer); anthers violet (only exceptionally yellow) 1. **S. sagittifolia** L.
- + Lobes of emersed leaves usually one-third as long as the blade; anthers yellow 3. **S. natans** Pall.

1. **S. sagittifolia** L. Sp. pl. (1753), 993; Ldb. Fl. Ross. IV, 41 pro parte; Kryl., Fl. Zap. Sib. I, 124. — Ic.: Rchb. Ic. VII, t. LIII, fig. 94.

* From Latin *sagitta*, arrow, referring to the shape of the leaf blade.

Perennial; rootstock short, fibrous, emitting long stolons, these forming in fall acorn-shaped tubers at their ends; leaf rosettes varying greatly in shape, may be classified in 3 types: submersed, sessile, linear, obtuse, translucent, parallel-nerved, to 80 cm long, 3–20 mm broad; floating, long-petioled, the blade 3.5–14 cm long, 2.5–7.5 cm broad, oblong-lanceolate, ovate or elliptic, with a deep sinus at base and 2 short approximate lobes; emersed, the sagittate-triangular base 6.5–15 (–25) cm long and (0.5–) 4–12 (–22) cm broad, the divergent lanceolate or linear lobes about as long as the blade; often present only leaves of one or two types; scape (10–) 20–100 cm long, simple or slightly branched, stoutish, 3-angled, as long as or shorter than the leaves; flowers in numerous whorls of 3, of these the lowest (rarely 2 lowest) pistillate; pistillate pedicels half as long as those of the staminate flowers in upper whorls; sepals broadly ovate, 6–7 mm long; petals to 1.5 cm long, white, with a violet claw; stamens 2–3 mm long, the filament as long as the anthers; anthers violet (very rarely yellow – *f. xanthanthera* Holmb.); fruiting heads short-stalked or subsessile; fruits large, ca. 4–5.5 mm in diameter, obliquely and broadly obovoid to irregularly globose, with broadly rounded equal margins and an almost straight beak. (Plate XIV, Figure 7 a–b).

Sluggish or standing waters and their shores. June–August. European part: from Kar. -Lap. and Dv. -Pech, to the S., in all regions; Caucasus: Cisc., E. Transc., S. Transc.; W. Siberia: Ob, Irt., Alt.; E. Siberia: Ang. -Say. **Gen. distr.:** W. Europe. Described from Europe (erroneously reported by Linnaeus for America).

Economic importance. The acornlike tubers formed in fall at the ends of axillary stolons are edible. Baked tubers are eaten in the USSR, e. g., by Kalmucks, and in W. Europe in France, etc. The taste is compared by Bois to that of chestnuts. Difficulties involved in collecting the tubers prevent their wider use.

2. *S. trifolia* L. Sp. pl. (1753), 993; Kryl., Fl. Zap. Sib. I, 125. – *S. sagittifolia* Ldb. Fl. Ross. IV, 41 pro parte. – *S. sinensis* Sims, Curtis's. Bot. Mag. (1813), 1631. – *S. hirundinacea* Blume Enum. pl. Javae (1827) 34. – Ic.: Gorodkov in Trav. Mus. Bot. Ac. Sc. Petersb. X (1913), 158, 167. – Exs.: H. Fl. As. med., No. 415.

Perennial; rootstock emitting tuberiferous stolons; leaves sagittate, the broadly elliptic blade twice as long as broad, the narrowly triangular lobes as long as or commonly longer than the blade; of frequent occurrence are forms with very narrow sublinear blade and lobes (*S. angustifolia* Sieb. in herb.); scape simple or branched; pistillate flowers in 1–4 lower whorls with shorter pedicels (in fruit 0.6–2 cm long); staminate flowers long-pedicled; petals white throughout; anthers yellow; fruits irregularly and broadly triangular, broad-winged, with incised margins or almost entire; beak curved. (Plate XIV, Figure 8, c).

Shores of rivers, lakes, irrigation ditches, etc. – Caucasus: W. and E. Transc., Tal.; W. Siberia: Irt. (Pavlodar County); Centr. Asia: Balkh., Ar. -Casp., Kyz. K., Syr D., T. Sh. (W.), Pam. -Al.; E. Siberia: Dau.; Far East: Ze. -Bu., Uss. **Gen. distr.:** S. Asia from Persia to Japan, to the S. as far as the Sunda Islands. Described from China (according to illustration in Petiver Gaz. 29, t. 19, f. 3).

Economic importance. Tubers edible. A special large-leaved cultivated race, undoubtedly derived from this species, with much larger tubers than in

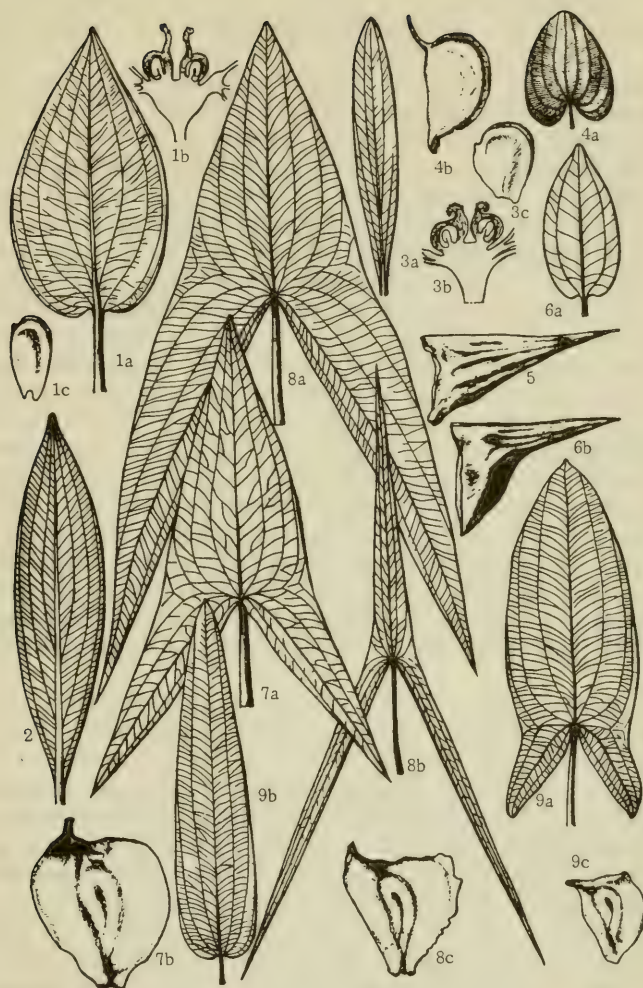


PLATE XIV

1. *Alisma plantago-aquatica* L.: a) leaf; b) middle part of flower in longitudinal section; c) fruit.—
 2. *A. lanceolatum* With.: leaf.— 3. *A. Loeselii* Gorski: a) leaf(emersed); b) middle part of flower in longitudinal section; c) fruit.— 4. *Caldesia parnassiifolia*: a) leaf; b) fruit.—
 5. *Damasonium alisma* Mill.: fruit.— 6. *D. constrictum* Juz.: a) leaf; b) fruit.—
 7. *Sagittaria sagittifolia* L.: a) leaf; b) fruit.— 8. *S. trifolia* L.: a) leaf (typical form); b) leaf (narrow-leaved form); c) fruit.— 9. *S. natans* Pall.: a) emerged leaf; b) floating leaf; c) fruit.

the wild form (on the average ca. 6 cm long and 2–4 cm in diameter), is grown in China and Japan for the sake of the tubers and their starch content. It is often described as a distinct species (*S. sinensis* Sims., *S. macrophylla* Bge, etc.; vernacular names — Fsz'ki in China, Konwai in Japan). The crop requires a marshy soil; it gives high yields (a single plant producing 10–15 tubers, with an average tuber weight of about 14 g).

- 291 3. *S. natans* Pall. Reise III (1776) 321 (nomen), append. 757; Kryl., Fl. Zap. Sib. I, 126. — *S. alpina* Willd. Sp. pl. IV (1805) 408. — *S. sagittifolia* Ldb. Fl. Ross. IV, 41 pro parte. — Ic.: Pall., l. c., tab. G, fig. 3, Gorodkov, l. c., p. 160, 167. — Exs.: Dörf. Herb. Norm., No. 4377; Pl. Finl., No. 440.

Perennial; rootstock with tuberiferous stolons; submersed leaves linear, sessile; floating leaves long-petioled, the blade linear-lanceolate, lanceolate or oblong, narrowed or rounded at base, or else oblong-elliptic with cordate-sagittate base and 2 short commonly obtuse lobes; emersed leaves sagittate, the pointed lobes one-third or rarely one-half as long as the blade; scape 7–50 cm long or longer, slender, terete, simple, longer than the leaves; flowers in 2 or 3 whorls of 3, the lowest whorl pistillate, the upper whorls staminate, the staminate pedicels to 2 cm long; petals small, white; anthers yellow; fruiting heads round, on stalks 2–5 mm long; fruits small, 1.5–2 mm broad, irregularly and narrowly triangular, narrow-winged, almost entire, the short beak curved. July–August. (Plate XIV, Figure 9 a–c).

Rivers and lakes. — European part: Kar. -Lap., Dv. -Pech., V. -Kama, U. V.; W. Siberia: Ob, Irt., Alt.; E. Siberia: Yen., Ang. -Say., Lena-Kol., Dau.; Far East: Ze. -Bu., Uda, Sakh., Okh., Kamch. **Gen. distr.:** Scand., Manchuria. Described from Dauria (Shaksha, Dzheruna).

Hybrid: *S. natans* Pall. × *S. trifolia* L. — Uss.; also known from Manchuria.

4. *S. graminea* Michx. Fl. Bor. -Am. II (1803) 190. — Ic.: Britt. et Br. Ill. Fl., fig. 204.

Perennial; emersed leaves petiolate, the lanceolate or elliptic blade 3–15 cm long, usually without basal lobes; scape 10–15 cm long, erect, simple, mostly with few whorls; pistillate and staminate pedicels about the same length; flowers 1–2 cm in diameter; filaments of stamens dilated, hairy; anthers yellow; fruits 1–5 mm long, cuneate, winged, with a very short beak.

Reported by A. A. Grossgeim (Fl. Kavk.) for the Caucasus as an adventive plant: W. Transc. (Batumi). **Gen. distr.:** N. Am. Described from Canada.

Family XXII. **BUTOMACEAE** S. F. GRAY*

Perennial, paludal or aquatic plants; leaves mostly all radical and then stem a leafless scape; flowers actinomorphic, perfect; outer perianth segments 3, mostly coriaceous, green or somewhat colored, corolloid; inner segments 3, larger than the outer, thinner, often caducous; stamens 9

* Arranged by B. A. Fedchenko.

292 or many, distinct; pistils commonly 6, in 2 series, each ovary containing many ovules; fruit consisting of separate or sometimes somewhat coherent fruitlets [follicles]; seeds exalbuminous; embryo straight.

Genus 62. **BUTOMUS** L.
L. Gen. pl. ed. 1 (1737) 121.

Scapigerous plants; leaves all radical, linear-ensiform; inflorescence umbellate; outer perianth segments [sepals] colored, corolliform; inner segments [petals] persistent; stamens 9, all fertile, 3 opposite the sepals and 6 in pairs opposite the petals; filaments slender, the basifixed anthers dehiscent by a longitudinal lateral slit; fruit consisting of 6 follicles, these 1-locular, arranged in a circle, many-seeded, slightly coherent at base, dehiscent adaxially; seeds many, straight, striate.

- 1. Scapes to 1½ m high; umbel many-flowered; stigma curved 1. **B. umbellatus** L.
- + Scapes not more than 60 cm high; flowers few; stigma straight 2. **B. junceus** Turcz.

1. **B. umbellatus** L. Sp. pl. (1753) 372; Ldb. Fl. Ross. IV, 43; Kryl., Fl. Zap. Sib. I, 127. — Exs.: Tauch. Herb. Boh., No. 1544; Fl. Hung., No. 260. — Ic.: Fl. Dan., t. 604; Rchb. Ic. fl. germ. V, t. 58.

Perennial; stem 40–150 cm long; scapes terete, smooth; leaves triquetrous at base, flat above, linear, 3–10 mm broad, in running water much elongated and slender (var. *vallisneriaefolia* Sagorski); umbels many-flowered; involucre bracts triangular-lanceolate, acuminate; pedicels much longer than flowers; perianth large, to 25 mm in diameter. June–July.

Standing or sluggish waters. — European part: all regions; Caucasus: all regions; W. Siberia: all regions; E. Siberia: Yen., Ang.-Say., Dau.; Far East: Uss.; Centr. Asia: Ar.-Casp., Balkh., Kara K., Amu D., Syr D. **Gen. distr.:** Scand., Centr. Eur., Atl. Eur., Bal.-As. Min., Iran., Ind.-Him. Described from Europe. Type in London.

Economic importance. The leaves are used for making mats and baskets. Baked rootstocks are used for food by Kalmucks, Moldavians [Mordvinians?] and Yakuts as one of their principal food products; in years of hunger they have been used in some localities as a substitute for bread.

- 293 2. **B. junceus** Turcz. Catal. pl. baical., No. 1079 in Bull. Soc. Nat. Moscou (1838); Turcz. Fl. baic.-dah. II, 156. — **B. umbellatus** var. *minor* Ldb. Fl. ross. IV (1853), 44. — **B. umbellatus** var. *junceus* M. Micheli in DC. Mon. Phan. III (1881), 85. — Ic.: V. Petr., Fl. Yakutii, Fig. 34. — Exs.: Griff. Afgansit., No. 5402. Yakutian: kel'asa, kiel'.

Perennial; closely related to the preceding species, but readily distinguishable by its smaller dimensions; stem 30–50 cm high; leaves of riparian, aquatic and terrestrial plants (f. *erecta* V. Petr.) thinner, glaucescent, erect, strict, narrowly linear, to 3 mm broad, sharply keeled in upper part; leaves of submersed deep-water forms (f. *natans* V. Petr.) floating, soft, not keeled; flowers to 1.5 cm in diam.; petals much smaller than sepals. July. (Plate X, Figure 7 a–c).

Shores of oxbows and lakes, brackish bogs, and as weeds in ricefields. — E. Siberia: Lena-Kol., Ang.-Say.; Centr. Asia: Balkh., Kara K., Amu D. **Gen. distr.:** Ind.-Him. Described from the Baikal area. Type in Leningrad.

Family XXIII. **HYDROCHARITACEAE** ASCHERS*

Aquatic perennials; flowers mostly emersed, the leaves submersed or floating; leaves alternate, rarely verticillate, with axillary scales; flowers solitary or in cymes subtended by two connate bracts forming a spathe, unisexual, rarely perfect, small and insignificant or fairly large with a conspicuous perianth; perianth biseriate, the inner series sometimes white-colored corolloid; stamens in 1 to several (up to 5) series; pistil of 2–15 coherent carpels; ovary inferior, 1-locular or seemingly many-locular; stigmas as many as carpels.

- 294

1. Leaves floating, the blade orbicular 68. **Hydrocharis** L.

+ Leaves submersed or sometimes emersed, linear or lanceolate, rarely cordate at base 2.

2. Leaves in whorls on the stem 3.

+ Leaves all radical or in many-leaved rosettes on runners 4.

3. Leaves in whorls of 3–6, the margin sharply toothed 63. **Hydrilla** L. C. Rich.

+ Leaves commonly in whorls of 3, the margin obscurely serrulate 64. **Elodea** L. C. Rich.

4. Leaves spinous-dentate 66. **Stratiotes** L.

+ Leaves entire 5.

5. Leaves ribbonlike; flowers inconspicuous; pistillate flowers raised on long spirally twisted peduncles 65. **Vallisneria** L.

+ Leaves petiolate, with a broadly ovate or cordate blade; flowers large, azure 67. **Ottelia** Pers.

Genus 63. **HYDRILLA** L. C. RICH.
L. Rich. in Mémoir. de l'Institut II (1811) 61.

Internodes elongated; leaves in whorls, dentate, with a pair of linear fringed scales at their axils; flowers unisexual; spathe of staminate flowers subspherical, irregularly bifid; spathe of pistillate flowers tubular, 2-valved; ovules 2–7; stigma entire.

1. **B. verticillata** (L. f.) L. C. Rich. in Mémoir. de l'Institut II (1811), 61. — *H. verticillata* var. *lithuanica* Schmalh. Fl. II (1897), 442. — *Serpicula verticillata* L. fil. Suppl. (1781), 416. — *Udora lithuanica* Bess. in Flora II, Beibl.; (1832) 12; Ldb. Fl. Ross. IV, 47. — Ic.: Rchb. VII, t. LIX; Engl. et Prantl. II, fig. 184. — Exs.: Rchb. Fl. germ., No. 2142 (*U. pomeranica* Rchb.); Griffith Bengal, No. 6043; Franchet et Savatier Japon, No. 1241; HFR, No. 1936 (var. *Roxburgii*).

* - Arranged by B. A. Fedchenko.

Perennial; stem elongated, sparingly branched, with rather long internodes; winter buds scattered on the branches, deciduous in fall; leaves 3—8 in a whorl, rarely paired, to 2 cm long, flat, straight (var. *gracilis* Casp.), sometimes merely to 1.5 cm long, more rigid and somewhat recurved (var. *crispa* Casp.); monoecious plants with inconspicuous solitary flowers; spathe univalvular; pistillate flowers long-pedicelled; staminate flowers containing 3 stamens and sometimes 3 staminodes, 3 sepals and 3 petals. (Plate X, Figure 12 a—b).

Standing or sluggish waters. — European part: U. Dnp. (Lake Sosna, 21 km N. of Vitebsk); W. Siberia: Irt., Alt.; Far East: Amur, Uss.

Gen. distr.: Scand. (Pomerania, Prussia, Lithuania, Latvia), Ind. -Him., Jap. -Ch., Afr., Aust. Described from India. Type in Paris.

Genus 64. **ELODEA** L. C. RICH.

L. Rich. in Michx. Fl. bor.-amer. I (1802) 20.

Submerged plants, with an elongated much-branched stem, usually destitute of winter buds; leaves verticillate, (2) 3—(6) in a whorl, serrulate-margined, with a pair of entire axillary scales at base; flowering spathe ovate or linear, bifid; flowers perfect or unisexual and then the plants dioecious; stamens 3—9; ovules 3 to many.

- 295 1. **E. canadensis** Rich. in Michx. Fl. bor. amer. (1803) I, 20 (1803); Kryl., Fl. Zap. Sib. I, 130. — *Anacharis canadensis* Asa Gray Man. Bot. North Un. St. ed. I (1856), 441; Shmal'g. II, 448. — Ic.: Torrey Fl. State New York, t. 125, Engl. et Prantl. II, I, 184. — Exs.: *Kicksia belgica*, No. 474; Hayek Fl. stir. exs. No. 54; Fl. Hung. exs., No. 792.

Perennial; stem long, often branched; leaves commonly 3 in a whorl, oblong-ovate to linear-lanceolate, acute, serrulate on the keel; flowers dioecious or perfect; staminate flowers subsessile, the 9 sessile anthers breaking off at anthesis or raised to the surface by the elongating pedicel; in the USSR, as in W. Europe, staminate flowers do not occur and there are only pistillate plants; pistillate flowers solitary, raised to the surface on a long stalk [hypanthium]; sepals 3, reddish or greenish; petals 3, whitish, orbicular; ovary containing 3—20 ovules; stigmas 3; May, June, July.

Standing or sluggish waters, in ponds, backwaters, oxbows, canals, etc. — European part: Lad. -Ilm., U. V., M. Dnp., V. -Don, Bl., L. Don; W. Siberia: Ob. **Gen. distr.:** Native in N. Am., whence introduced into Europe: Atl. Eur., Med., Scand., Asia, and Australia.

Economic importance. Occurring in great abundance, water-weeds fill waterways and impede their economic utilization, interfering with fishing, navigation, etc. On the other hand, the bulky green matter may be variously exploited (e. g., for fertilization; as feed for pigs, etc.).

Note. *E. densa* Caspary Monatsber. Berl. Acad. 1857, 49. Larger than the preceding; leaves 4 or 5 in a whorl, with a crenulate margin; staminate flowers to 2 cm in diameter. Naturalized in some water bodies of Abkhazia, where they found their way from domestic aquaria. Native in Argentina.

Genus 65. **VALLISNERIA** L.

L. Gen. pl. ed. 1 (1737) 300; L. Gen. pl. ed. 5 (1754) 446.

Aquatic plants; rootstock creeping, giving rise to leaf rosettes or with alternate leaves borne on a branched stem; dioecious plants; staminate flowers several together, inclosed in 1-valved spathe, several heads arising from the same axil; androecium commonly of 2 stamens and 1 staminode; ovary in pistillate flowers cylindric, many-ovuled.

Subgenus **PHYSCIUM** (Lour.) Asch. et Guerke in Engl. Prantl. Nat. Pflanzenf. II, 1 (1889) 251. — *Physcium* Lour. Fl. Cochinch., p. 662 (1790) pro genere. Rootstock creeping; leaves rosulate.

1. **V. spiralis** L. Sp. pl. (1753) 1015; Ldb. Fl. Ross. IV, 46; Shmal'g. II, II, 443. Exs.: Rchb. Fl. exs., No. 2502; Fl. exs. Austro-Hung., No. 1033; 296 Fl. exs. Hung., No. 89; Schultz Herb. norm., No. 143. — Ic.: Rchb. ic. VII, t. IX, f. 108—110; Engl. et Prantl. II, 1, f. 185.

Perennial; leaves linear, to 80 cm long and 12 mm broad, serrulate at top, obtuse; staminate flowers short-pedicel, in dense clusters, breaking off at anthesis and floating to the surface where pollination occurs; pistillate flowers solitary, on very long spirally twisted peduncles. (Plate X, Figure 10 a—c).

Bottom of shallow, standing or slow-flowing waters, not descending beyond a depth of 1 m, sometimes forming dense thickets; in vegetative condition easily distinguishable from other aquatic plants with similar leaves (e.g., certain forms of *Sagittaria*, *Sparganium*, *Alisma*) by the shape of the cells of the leaf blade. — European part: Bl., L. V.; Caucasus: Cisc.; Centr. Asia: Kyz. K.; Far East: Lake Khapovo.

Gen. distr.: Med., Paleotropical and Neotropical regions, N. Am. Described from Pisa and Florence. Type in London.

Genus 66. **STRATIOTES** L.

L. Gen. pl. ed. 1 (1737) 161; ed. 5 (1754) 238.

Submerged plants, usually with firm emersed leaves in spiral rosettes, dioecious; peduncles long, 2-keeled; spathe 2-valved; sepals shorter than petals, oblong; staminate flowers long-pedicel, exserted from the spathe; nectaries 15—30, pale yellow, threadlike, glandular; stamens in 3 series; pistillate flowers short-pedicel, sometimes 2 in a spathe; stigmas 6; fruit seemingly 6-locular.

Fossils are known from Tertiary and Quaternary formations in the USSR of *Stratiotes aloides* L. from interglacial layers of U. V. (Likhvin) and U. Dnp. (Mikulino).

1. **S. aloides** L. Sp. pl. (1753) 535; Ldb. Fl. Ross. IV, 45. — Ic.: Fl. dan. II, 337; Rchb. VI, t. XI, f. 11; Irmisch in Flora, 1865, 81, t. I, f. 1—8. — Exs.: Fl. exs. Austro-Hung., No. 1478; *Kicksia belgica*, No. 278.

Perennial; shoots stoutish, bearing leaf rosettes; leaves ensiform, very firm, 3-angled, flat at top, spinous, to 40 cm long and to 4 cm broad, rising at anthesis above water surface and then again submerged; sepals ovate;

petals 3, white, obovate, to 3 cm long; stamens about 12; fruit ovoid, 6-angled. (Plate X, Figure 9 a—b).

Backwaters, oxbows, ponds, and lakes, in standing and slow-flowing water, often in enormous masses. — European part: all regions, except Crimea and L. V.; Caucasus: Cisc.; W. Siberia: Ob, U. Tob., Irt.

Gen. distr.: Scand., Balt., Atl. Eur., Med. Described from N. Europe. Type in London.

Economic importance. Occurring in great abundance in bodies of water, 297 representing a considerable accumulation of organic matter and used in some places for fertilization of fields and market gardens as well as for feeding certain domestic animals, such as pigs.

Genus 67. **OTTELIA** PERS.

Pers. Synops. I (1805) 400.

Submerged aquatics, the rootstock giving rise to a cluster of long-petioled leaves; flowers perfect, borne on long scapes; spathe commonly with 2—6 winged ribs, inclosing a solitary flower; sepals oblong, much shorter than petals; stamens triseriate, the outer series double, the inner series sometimes wanting.

1. **O. alismoides** (L.) Pers. Synops. I (1805) 400. — *Stratiotes alismoides* L. Sp. pl. (1753) 535. — Ic.: Engl. u. Prantl II, fig. 100; Kom. in Izv. SPb. Bot. sada X (1910) 122. — Exs.: Cuming, Merrill, No. 5038; Asch. Lyb., No. 488; Horsfield Java, No. 100; Wrght Ind or., No. 2485.

Perennial; lower leaves linear, the upper broadly ovate, to 21 mm long and 15 mm broad, mucronate, prominently 9-nerved (var. *lacustris* Kom.). August—September.

Flowers pale blue, to 35 mm in diameter, with elongated tube; ovary inclosed in the tube. (Plate X, Figure 14 a—b).

In standing water of lakelets, oxbows, and backwaters. — Far East; Uss. **Gen. distr.:** Paleotropical Region, Jap.-Ch. Described from India. Type in London.

Genus 68. **HYDROCHARIS** L.

L. Gen. pl. ed. 1a (1737) 308; ed. 5 (1754) 458.

Profusely stoloniferous aquatic plants; leaves long-petioled, floating; sepals ovate; petals orbicular; staminate flowers solitary or several together; stamens 4-seriate, the outer series consisting of staminodes; the flower center occupied by 3 spherical glands; pistillate flowers long-pedicceled, containing 3 sometimes double staminodes; stigmas 6.

Known among fossils from Tertiary and Quaternary formations of the USSR — *Hydrocharis morsus ranae* L. from interglacial layers of U. V. (Borok).

- | | |
|---|------------------------------|
| 1. Staminate flowers 2—4 together | 1. H. morsus ranae L. |
| + Staminate flowers solitary | 2. H. asiatica Miq. |

1. **H. morsus ranae** L. Sp. pl. (1753) 1036; Kryl., Fl. Zap. Sib. I, 131; Ldb. Fl. Ross. IV, 45; Shmal'g. II, 444; 25, VII. — Ic.: Rchb. Ic., t. LXII, f. 112; Engl. u. Prantl. II, 1 f., 191. — Exs.: Welw. Lusit, No. 802.

Perennial; stolons terminating in summer in leaf rosettes and in fall in slender detachable winter buds [turions] consisting of scalelike leaves; rosulate leaves few, with an orbicular broadly cordate-based blade and 2 stipules; staminate flowers mostly in threes, with a rudimentary ovary at the flower center; pistillate flowers smaller than the staminate; stigma 2-lobed. (Plate X, Figure 13 a—b).

Standing and slow-flowing waters, mainly in oxbows, backwaters, ponds, the riparian zone of lakes, and reed beds. — European part: all regions, except Crimea; Caucasus: Cisc., W. Transc., Tal.; W. Siberia: Ob, U. Tob., Irt., Alt.; E. Siberia: Yen.; Centr. Asia: Balkh. **Gen. distr.:** Scand., Atl. Eur., Med. Described from Europe. Type in London.

2. **H. asiatica** Miq. Fl. Ind. Batav. III (1855) 239. — **H. cellulosa** Buch. Ham. in Wall. Cat. Ind. or. (1824) nomen solum. — **H. morsus ranae** Forbes et Hemsley Ind. fl. sin. (1903) III, 2; Hook. Fl. br. Ind., V, 662 (non L.). — Exs.: Henry Ichang, No. 2256.

Perennial, resembling the preceding; middle portion of leaves pulvinately inflated beneath by expansion of intercellular air spaces; stamens quite free; stigma biparted.

Inlets at the estuaries of small rivers discharging into Lake Khanka. — Far East: Uss. **Gen. distr.:** Paleotropical Region, China. Described from India. Type in London.

ALPHABETICAL LIST
of Families and Genera Appearing in Volume I

	English page	Russian page		English page	Russian page
Abies Hill.	104	134	Elodea L. C. Rich.	231	294
Adiantum L.	61	79	Ephedra L.	154	195
Alisma L.	219	279	Ephedraceae Wettst.	154	195
Alismaceae.	218	278	Equisetaceae L. C. Rich.	78	101
Alismataceae DC	218	278	Equisetum L.	78	101
Anogramme Link.	56	73	Frenela Mirbel	151	191
Araucariaceae Strasb.	103	133	*Ginkgo L.	101	130
Asplenium L.	48	61	*Ginkgoaceae Engl.	101	130
Asplenites Goepp.	48	62	Gleichenia Sm.	67	87
Athyrium Roth.	41	51	Gleicheniaceae Br.	67	87
Azolla Lam.	70	90	Glyptostrobus Endl.	137	173
* Biota D. Don.	152	192	Groenlandia J. Gay	205	261
Blechnum L.	55	71	Hydrilla L. C. Rich.	230	294
Botrychium Sw.	73	94	Hydrocharis L.	233	297
Butomaceae S. F. Gray	228	291	Hydrocharitaceae Aschers.	230	293
Butomus L.	229	292	Hymenophyllaceae Bory.	15	17
Caldesia Par.	222	283	Hymenophyllum Smith.	15	18
Callitris Vent.	151	191	Isoetaceae Bartling.	98	127
Camptosorus Link.	47	61	Isoetes L.	98	127
* Cedrus Link.	124	159	Juncaginaceae Lindl.	216	275
Ceterach Willd.	55	71	Juniperus L.	137	174
Cheilanthes Sw.	58	74	Larix Mill.	120	153
Chrysodium Fée	16,67	18,87	Libocédrus Endl.	153	194
Coniogramma Fée.	57	73	Lycopodiaceae L. C. Rich.	86	112
Cryptogramma R. Br.	60	77	Lycopodium L.	87	112
* Cupressaceae F. W. Neger.	137	173	Lygodium Sw.	67	87
Cupressus L.	153	194	Marattiaceae Kaulf.	71	92
* Cycadaceae Lindl.	100	129	Marsilea L.	70	91
* Cycas L.	100	129	Marsileaceae R. Br.	70	90
Cyclophorus Desv.	66	86	Microlepia Presl.	39	49
Cystopteris Bernh.	20	24	Mikrobiota Kom.	152	193
Dammara L.	103	133	Najadaceae Benth. et Hook. f.	212	269
Damasonium Juss.	224	285	Najas L.	212	269
Danaeites Goepp.	71	92	Notholaena R. Br.	57	74
Dryopteris Adans.	24	30	Onoclea L.	24	29
Elisma Buchen.	223	284	Ophioglossaceae R. Br.	71	92

(Items marked with an asterisk are known only in culture, letterspaced items are known only as fossils.)

	English page	Russian page		English page	Russian page
Ophioglossum L.	72	92	Schizaeaceae Rchb.	67	87
Osmunda L.	68	87	Selaginella Spring. . . .	94	123
Osmundaceae Brongn. . .	67	87	Selaginellaceae Metten.	94	122
Osmundites Ung.	67	87	Sequoia Endl.	136	173
Ottelia Pers.	233	297	Sparganiaceae Engl. . .	170	216
Phyllitis Ludwig.	47	60	Sparganium L.	170	217
Phyllospadix Hook. . . .	211	268	Stratiotes L.	232	296
Picea Dietrich	111	142	Struthiopeteris Haller . .	23	29
Pilularia L.	70	90	Taxaceae Lindl.	101	131
Pinaceae Lindl.	104	133	Taxus L.	102	131
Pinus L.	125	159	Taxodiaceae F. Neger	136	173
Pleurosoriopsis Fom. . . .	54	70	Taxodium Richard . .	137	173
Podocarpaceae F. Neger	103	133	* Thuja Tourn.	151	192
Podocarpus L. Herit. . .	103	133	Trichomanes L.	15	17
Polypodiaceae R. Br. . . .	16	18	Triglochin L.	217	276
Polypodium L. Polystich. .	65	84	Tsuga Carr.	111	142
Polystichum Roth.	35	45	Typha L.	165	210
Posidonia Koenig	209	265	Typhaceae J. St. Hil. . .	165	209
Potamogeton L.	181	230	Vallisneria L.	232	295
Potamogetonaceae Engl. .	180	229	Widdringtonia Endl.	151	191
Pteridium Gled.	64	83	Woodsia R. Br.	17	19
Pteris L.	62	80	Woodwardia Sm. . .	56	72
Ruppia L.	205	261	Woodwardites Goepp.	56	72
Sagittaria L.	225	286	Zannichellia L.	207	263
Salvinia Micheli	69	89	Zostera L.	209	266
Salviniaceae Bartl.	69	89	Zosteraceae Lindl. . . .	209	265
Scheuchzeria L.	218	277			

VEGETATION REGIONS OF THE USSR

Abbreviated name	Full name
I. Arctic	
1. Arc. Eur.	Arctic (European part)
2. Nov. Z.	Novaya Zemlya
3. Arc. Sib.	Arctic (Siberia)
4. Chuk.	Chukchi
5. An.	Anadyr
II. European part	
6. Kar.-Lap.	Karelia-Lapland
7. Dv.-Pech.	Dvina-Pechora
8. Balt.	Baltic States
9. Lad.-Ilm.	Ladoga-Il'men
10. U. V.	Upper Volga
11. V.-Kama	Volga-Kama
12. U. Dnp.	Upper Dnieper
13. M. D.	Middle Dnieper
14. V.-Don	Volga-Don
15. Transv.	Transvolga area
16. U. Dns.	Upper Dniester
17. Bes.	Bessarabia
18. Bl.	Black Sea area
19. Crim.	Crimea
20. L. Don	Lower Don
21. L. V.	Lower Volga
III. Caucasus	
22. Cisc.	Ciscaucasia
23. Dag.	Dagestan
24. W. Transc.	Western Transcaucasia
25. E. Transc.	Eastern Transcaucasia
26. S. Transc.	Southern Transcaucasia
27. Tal.	Talysh
IV. West Siberia	
28. Ob.	Ob region (from the eastern slopes of the Urals to the Yenisei R.)

29. U. Tob.	Upper Tobol
30. Irt.	Irtysh
31. Alt.	Altai

V. East Siberia

32. Yenisei.	Yenisei
33. Lena-Kol.	Lena-Kolyma
34. Ang.-Say.	Angara R.-Sayans
35. Dau.	Dauria

VI. Far East

36. Kamch.	Kamchatka
37. Okh.	Okhotsk
38. Ze.-Bu.	Zeya-Bureya
39. Uda	Uda R. area
40. Uss.	Ussuri
41. Sakh.	Sakhalin

VII. Soviet Central Asia

42. Ar.-Casp.	Aral-Caspian
43. Balkh.	Lake Balkhash area
44. Dzu.-Tarb.	Dzungaria-Tarbagatai
45. Kyz. K.	Kyzyl-Kum
46. Kara K.	Kara-Kum
47. Mtn.-Turkm.	Mountainous part of Turkmenistan
48. Amu D.	Amu Darya
49. Syr D.	Syr Darya
50. Pam.-Al.	Pamir-Alai
51. T. Sh.	Tien Shan

Accepted Regions for Indication of General Distribution of Species Appearing in "Flora of the U. S. S. R."

I. Arc.	- Arctic (Spitsbergen, Greenland and farther)
II. Scand.	- Scandinavia (Norway, Denmark, Sweden, Finland)
III. Centr. Eur.	- Central Europe (Germany, Poland, Czechoslovakia, Hungary, Austria, Switzerland)
IV. Atl. Eur.	- Atlantic Europe (Netherlands, Belgium, England, France, Portugal)
V. Med.	- Mediterranean (including North Africa) (V' Western, V'' Eastern)
VI. Bal.-As. Min.	- Balkan Peninsula and Asia Minor
VII. Arm.-Kurd.	- Lesser Armenia and Kurdistan
VIII. Iran.	- Iran and Afghanistan
IX. Ind.-Him.	- India and Himalayas

X.	Dzu. -Kash.	- [Dzungaria-Kashgar area] Eastern or Chinese Turkestan (Sinkiang)
XI.	Mong.	- Mongolia
XII.	Jap. -Ch.	- Japan and China
XIII.	Ber.	- North American coast of the Bering Sea
XIV.	N. Am.	- North America (U.S.A. and Canada)
XV.	Tib.	- Tibet

Other Geographical Abbreviations

Afr.	Africa
Aust.	Australia
Centr.	Central
E.	East(ern)
Gr.	Great, Greater
Is.	Island, Islands
Mt.	Mount
Mts.	Mountains
N.	North(ern)
R.	River
S.	South(ern)
W.	West(ern)

TRANSLATOR'S NOTE

The Russian term "Srednyaya Aziya" is in English Central Asia (or Soviet Central Asia). Therefore the term Middle Asia has been used for Russian "Tsentral'naya Aziya", which is non-Soviet inner Asia, comprising western China (Sinkiang and Tibet) and Mongolia.

EXPLANATORY LIST OF ABBREVIATIONS OF RUSSIAN
INSTITUTIONS AND PERIODICALS APPEARING
IN THIS TEXT

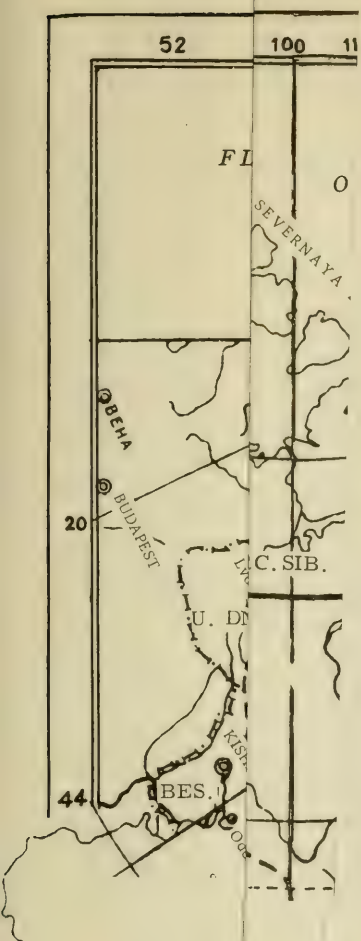
Abbreviation	Full names (transliterated)	Translation
Bot.-geogr. issled. v Turkest.	Botaniko-geograficheskie issledovaniya v Turkestane	Botanical and Geographical Investigations in Turkestan
Bot. Mat. Gerb. Bot. inst. AN SSSR	Botanicheskie Materialy Gerbariya Botaniches- kogo instituta AN SSSR	Botanical Materials of the Herbarium of the Botanical Institute of the Academy of Sciences of the USSR
Bot. Mat. Gerb. Gl. Bot. Sada	Botanicheskie Materialy Gerbariya Glavnogo Botanicheskogo Sada	Botanical Materials of the Herbarium of the Main Botanical Gardens
Bot. zap. SPb. univ.	Botanicheskie zapiski Sankt-Peterburgskogo universiteta	Botanical Notes of St. Petersburg University
Bot. zhurn. SSSR	Botanicheskii zhurnal SSSR	Botanical Journal of the USSR
Byull. Glavn. Bot. Sada	Byulleten' Glavnogo Botanicheskogo Sada	Bulletin of the Main Botanical Gardens
Byull. Obshch. lyubit. estest- vozn., antrop. i etnogr.	Byulleten' Obshchestva lyubitelei estestvozna- niya, antropologii i etnografii	Bulletin of the Naturalists', Anthropologists' and Etnographers' Society
Dendr.	Dendrarii	Arboretum
Der. i kust.	Derev'ya i kustarniki	Trees and Shrubs
Der. i kust. Kavk.	Derev'ya i kustarniki Kavkaza	Trees and Shrubs of the Caucasus
Dikie polezn. i technich. raste- niya SSSR	Dikie poleznye i tekhnichesk- skie rasteniya SSSR	Wild Useful Plants and Industrial Crops of the USSR
Dikorastuchie r. Kavkaza, ikh rasprostranenie, svoistva i pri- menenie	Dikorastushchie raste- niya Kavkaza, ikh ras- prostranenie, svoistva i primeneniye	Wild Plants of the Caucasus, Their Distribution, Properties and Uses
Dokl. AN Azerb. SSR	Doklady Akademii Nauk Azerbaidzhanskoi SSR	Reports of the Academy of Sciences of the Azerbaijan SSR
Fl.	Flora	Flora
Fl. Abkh.	Flora Abkhazii	Abkhazian Flora

Fl. Almat. zapovedn.	Flora Alma-Atinskogo zapovednika	Flora of the Alma-Ata Reserve
Fl. Alt.	Flora Altaya	Altai Flora
Fl. Alt. i Tomsk. gub.	Flora Altaiskoi i Tomskoi gubernii	Flora of Altai and Tomsk Provinces
Fl. Az. Ross.	Flora Aziatskoi Rossii	Flora of Asiatic Russia
Fl. Evrop. Rossii	Flora Evropeiskoi Rossii	Flora of European Russia
Fl. Gruzii	Flora Gruzii	Georgian Flora
Fl. Kamch.	Flora Kamchatki	Kamchatkan Flora
Fl. Kavk.	Flora Kavkaza	Caucasian Flora
Fl. Man'chzh.	Flora Man'chzhurii	Manchurian Flora
Fl. Sev. Kraya	Flora Severnogo Kraya	Flora of the Northern Territory
Fl. Sib.	Flora Sibiri	Siberian Flora
Fl. Sib. i Dal'n. Vost.	Flora Sibiri i Dal'nego Vostoka	Flora of Siberia and the Far East
Fl. Sr. Ross.	Flora srednei Rossii	Flora of Central Russia
Fl. Sr. i Yuzh, Ross.	Flora srednei i yuzhnei Rossii	Flora of Central and Southern Russia
Fl. Talysh.	Flora Talysha	Talysh Flora
Fl. Yugo-Vost.	Flora Yugo-Vostoka	Flora of the Southeast
Fl. Zap. Sib.	Flora Zapadnoi Sibiri	Flora of West Siberia
Gerb. donsk. fl.	Gerbarii donskoi flory	Herbarium of Don Flora
Gerb. Orlovsk. gub.	Gerbarii Orlovskoi gubernii	Herbarium of Orel Province
Gerb. Ukr. fl.	Gerbarii Ukrainskoi flory	Herbarium of Ukrainian Flora
GRF	Gerbarii Russkoi Flory	Herbarium of Russian Flora
Ill. Fl. Mosk. gub.	Illyustrirovannaya Flora Moskovskoi gubernii	Illustrated Flora of Moscow Province
Izv. AN SSSR	Izvestiya AN SSSR	Bulletin of the Academy of Sciences of the USSR
Izv. Bot. Sada	Izvestiya Botanicheskogo Sada	Bulletin of the Botanical Gardens
Izv. Bot. Sada. Petra Vel.	Izvestiya Botanicheskogo Sada Petra Velikogo	Bulletin of Peter the Great Botanical Gardens
Izv. Gl. Bot. Sada	Izvestiya glavnogo Bota- nicheskogo Sada	Bulletin of the Main Botanical Gardens
Izv. Kavk. Muzeya	Izvestiya Kavkazskogo Muzeya	Bulletin of the Caucasian Museum
Izv. Kazakhst. fil. AN SSSR	Izvestiya Kazakhstan- skogo Filiala Akademii Nauk SSSR	Bulletin of the Kazakhstan Branch of the Academy of Sciences of the USSR
Izv. Kievsk. Bot. Sada	Izvestiya Kievskogo Botanicheskogo Sada	Bulletin of the Kiev Botanical Gardens
Izv. Obshch. lyubit. estest. vozn., antrop. i etnogr.	Izvestiya Obshchestva lyubitelei estestvoznaniya, antropologii i etnografii	Bulletin of the Naturalists', Anthropologists' and Ethnographers' Society
Konsp. rast. okr. Khar'kova	Konspekt rastenii okrug Khar'kova	Compendium of Plants of Kharkov
Korm. rast estestv. senoko- sovi i pastb. SSSR	Kormovye rasteniya estest- vennykh senokosov i pastbishch SSSR	Fodder Plants of Natural Hay-meadows and Pastures of the USSR

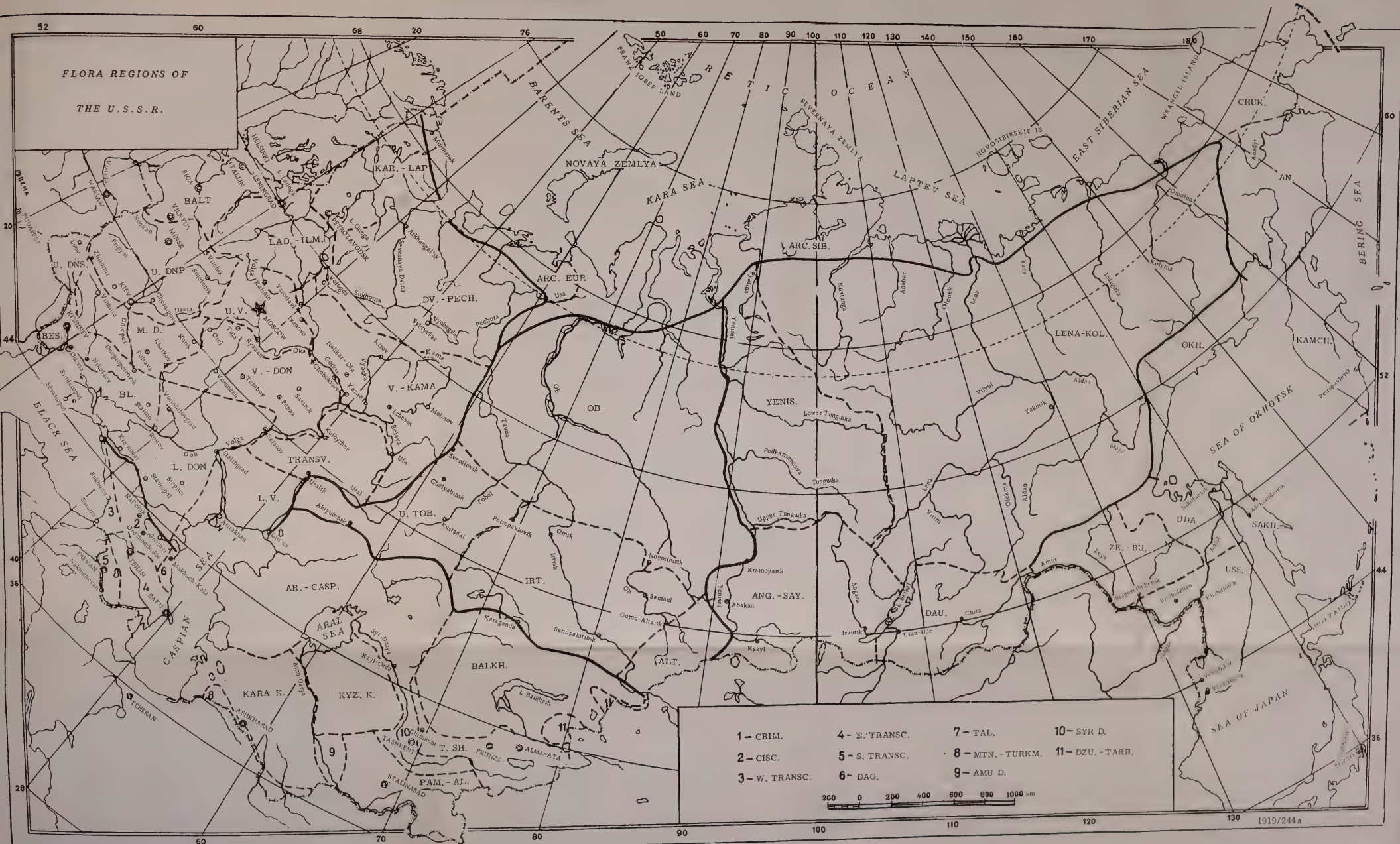
Lesn. zhurn.	Lesnoi zhurnal	Forestry Journal
Mat. (dlya) Fl.	Materialy dlya Flory	Materials on Caucasian
Kavk.	Kavkaza	Flora
Nov. obozr.	Novoe obozrenie	New Review
Och. obozr. i fl.	Ocherki rastitel'nosti i	Survey of Carpathian
Karpat	flory Karpat	Vegetation and Flora
Ocherk. Tifl. fl.	Ocherki Tiflisskoi flory	Survey of Tiflis [Tbilisi]
		Flora
Opis. Amur. obl.	Opisanie Amurskoi oblasti	Description of the Amur
		Region
Opred. der. i kust.	Opredelitel' derev'ev i	Key to Trees and Shrubs
	kustarnikov	
Opred. rast.	Opredelitel' rastenii	Key to Plants of Far
Dal'nevost. kr.	Dal'nevostochnogo kraya	Eastern Territory
Opred. rast. Kavk.	Opredelitel' rastenii	Key to Caucasian Plants
	Kavkaza	
Opred. vyssh. rast.	Opredelitel' vysshikh	Key to Higher Plants
	rastenii	
Opred. (vyssh.)	Opredelitel' (vysshikh)	Key to Higher Plants of
rasten. Evrop.	rastenii Evropeiskoi	the European USSR
casti SSSR	chasti SSSR	
Perech. rast.	Perechen' rastenii	List of Turkmenian Plants
Turk.	Turkmenii	
Putesh.	Puteshestviya	Travels
Rast. i fl. Karp.	Rasteniya i flora Karpat	Plants and Flora of the
		Carpathians
Rast. letn. pastb.	Rasteniya letnikh	Vegetation of Gandzha [now
Gandzh.	pastbishch Gandzhi	Kirovabad] Summer
		Pastures
Rast. res. Turkm.	Rastitel'nye resursy	Plant Resources of
	Turkmenii	Turkmenia
Rast. resursy	Rastitel'nye resursy	Plant Resources of the
Kavkaza	Kavkaza	Caucasus
Rast. Sib.	Rastitel'nost' Sibiri	Vegetation of Siberia
Rast. Sr. Az.	Rastitel'nost Srednei Azii	Vegetation of Soviet
		Central Asia
Rastit. Kavk.	Rastitel'nost' Kavkaza	Vegetation of the Caucasus
Rastit. pokrov.	Rastitel'nyi pokrov	Plant Cover of the Eastern
vost. Pamira	vostochnogo Pamira	Pamirs
Rastit. syr'e	Rastitel'noe syr'e	Plant Resources of
Kazakhst.	Kazakhstan	Kazakhstan
Rastit. Turkm.	Rasteniya Turkmenii	Vegetation of Turkmenia
Rezul't. dvukh pute-	Rezul'taty dvukh puteshest-	Results of Two Travels to
shestv. na Kavk.	vii na Kavkaz	the Caucasus
Russk. Fl.	Russkaya Flora	Russian Flora
Russk. lek. rast.	Russkie lekarstvennye	Russian Medicinal Plants
	rasteniya	
Sbor, sushka i raz.	Sbor, sushka i razvitie	Gathering, Drying and
lek. rast.	lekarstvennykh rastenii	Development of Medicinal
		Plants
Sorn. rast. SSSR	Sornye rasteniya SSSR	Weed Plants of the USSR
Sov. Bot.	Sovetskaya Botanika	Soviet Botany
Spis. rast.	Spisok rastenii	List of Plants

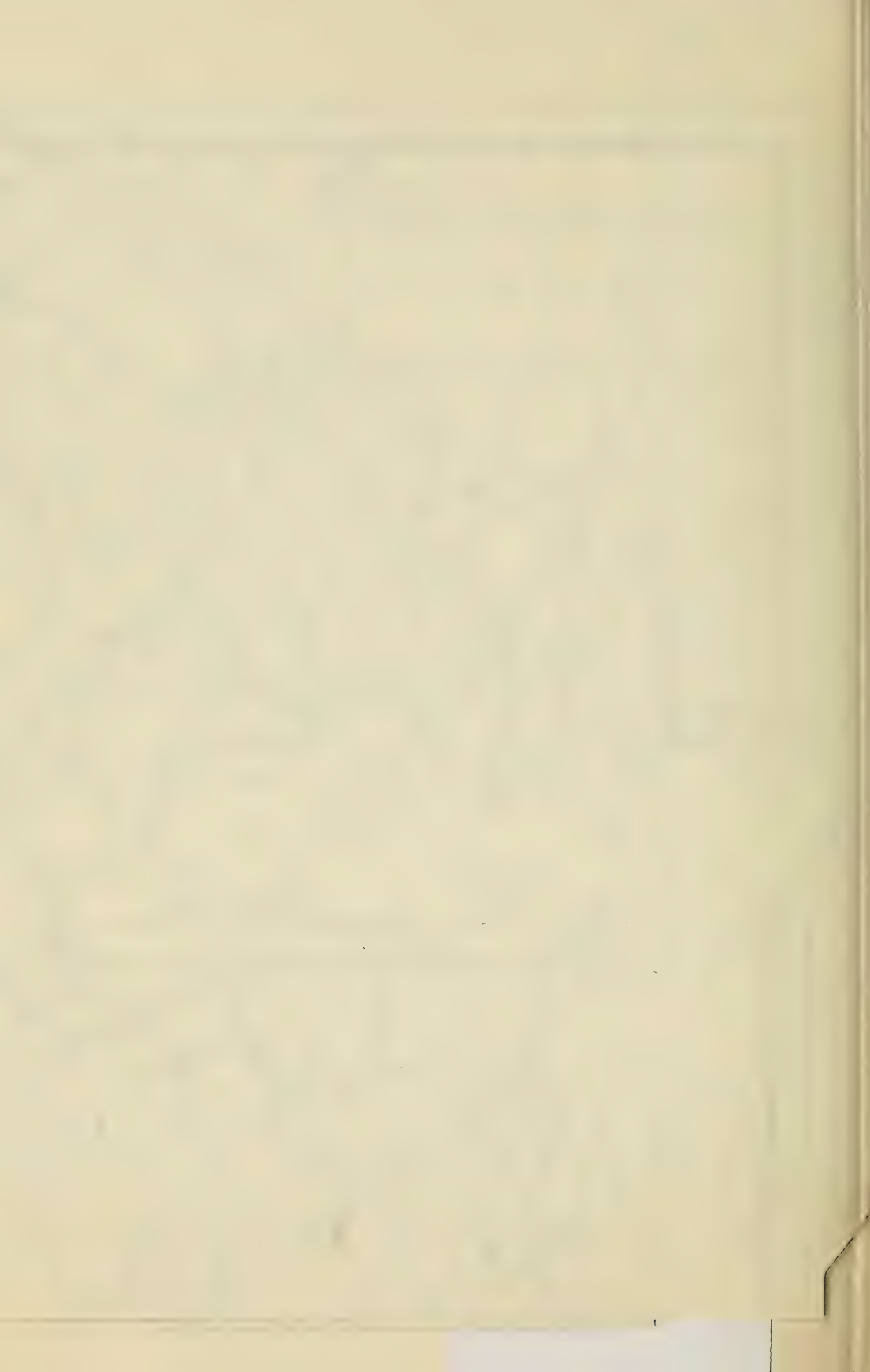
Tr. Bot. inst. AN SSSR	Trudy Botanicheskogo instituta AN SSSR	Transactions of the Botanical Institute of the Academy of Sciences of the USSR
Tr. Bot. Sada	Trudy Botanicheskogo Sada	Transactions of the Botanical Gardens
Tr. Bot. Sada Yur'evsk. Univ.	Trudy Botanicheskogo Sada Yur'evskogo Universiteta	Transactions of the Botanical Gardens of Yur'ev [now Tartu] University
Tr. Dal'nevost. bazy AN SSSR	Trudy Dal'nevostochnoi bazy AN SSSR	Transactions of the Far Eastern Base of the Academy of Sciences of the USSR
Tr. Inst. nov. lub. syr'ya	Trudy Instituta novogo lubyanogo syr'ya	Transactions of the Institute of New Fiber Raw Materials
Tr. Obshch. isp. prir. Khar'k. univ.	Trudy Obshchestva ispytatelei prirody Khar'kovskogo universiteta	Transactions of Naturalists' Society of Kharkov University
Tr. Peterb. obshch. estest- voisp.	Trudy Peterburgskogo obshchestva estestvoispytatelei	Transactions of St. Petersburg Naturalists' Society
Tr. pochv.-bot. eksp. Peresl, upr.	Trudy pochvenno- botanicheskoi ekspeditsii Pereslavskogo uprav- leniya	Transactions of the Soil- Botanical Expedition of Pereslavl Administration
Tr. po geobot. obsled. pastb. Azerb.	Trudy po geobotanicheskim obsledovaniyam past- bishch Azerbaidzhana	Transactions of Geobotanical Investigations of Azerbaijan SSR Pastures
Tr. prikl. bot. (gen. i sel.)	Trudy po prikladnoi botanike, genetike i selektivnoi	Transactions of Applied Botany, Genetics and Selection
Tr. Ross. Obshch. sadov.	Trudy Rossiiskogo obshchestva sadovodov	Transactions of the Russian Horticulturists' Society
Tr. SAGU	Trudy Sredneaziatskogo Gosudarstvennogo Universiteta	Transactions of the Soviet Central Asian State University
Tr. Sarat. obshch. estest- voisp.	Trudy Saratovskogo obshchestva estest- voispytatelei	Transactions of the Saratov Naturalists' Society
Tr. Sil'sko- gospod. komit. bot.	Trudy sil'skohospodar'- skoho komiteta botaniki	Transactions of the Botanical Agricultural Committee
Tr. SPb. obshch. estestv.	Trudy Sankt-Peterburg- skogo obshchestva estestvoispytatelei	Transactions of the St. Petersburg Naturalists' Society
Tr. Tadzh. bazy AN SSSR	Trudy Tadzhikskoi bazy AN SSSR	Transactions of the Tadzhikistan Base of the Academy of Sciences of the USSR
Tr. Tbil. bot. inst.	Trudy Tbiliskogo botani- cheskogo instituta	Transactions of Tbilisi Botanical Institute

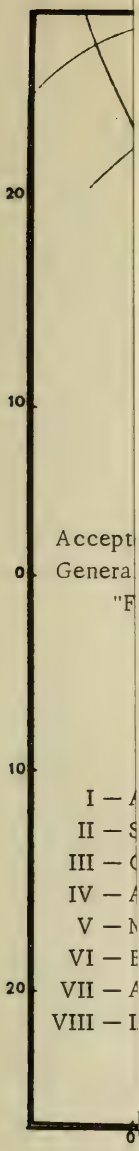
Tr. Tbil. (or Tifl.) bot. sada	Trudy Tbilisskogo (Tifliskogo) botaniche- skogo sada	Transactions of the Tbilisi (Tiflis) Botanical Garden
Tr. Turkmensk. bot. sada	Trudy Turkmenskogo botanicheskogo sada	Transactions of the Turkmenian Botanical Garden
Tr. Turk. nauchn. obshch.	Trudy Turkmenskogo nauchnogo obshchestva	Transactions of the Turkmenian Scientific Society
Vest. Akad. Nauk (or AN) Kazakhsk. SSR	Vestnik Akademii Nauk Kazakhskoi SSR	Bulletin of the Academy of Sciences of the Kazakh SSR
Vestn. estestv. nauk	Vestnik estestvennykh nauk	Bulletin of Natural Sciences
Vestn. Ross. Obshch. sadov.	Vestnik Rossiiskogo obshchestva sadovodov	Bulletin of the Russian Horticulturists' Society
Vest. Tifl. bot. sada	Vestnik Tiflisskogo botanicheskogo sada	Bulletin of Tiflis Botanical Garden
Vizn. (or Vznachn.) rosl. URSS	Viznachnyk roslyn USSR	Key to Plants of Ukrainian SSR
V obl. polupustyni	V oblasti polupustyni	(In the) Semidesert Region
Yadov. rast. lugov i pastb.	Yadovitye rasteniya lugov i pastbishch	Poisonous Plants of Meadows and Pastures
Zam. po sist. i geogr. rast. Tbil. bot. inst.	Zametki po sistematike i geografii rastenii Tbilisskogo botaniche- skogo instituta	Notes on Taxonomy and Geography of Plants of the Tbilisi Botanical Institute
Zhurn. Bot. obshch.	Zhurnal Botanicheskogo obshchestva	Journal of the Botanical Society
Zhurn. opytn. agron. Yugo- Vost.	Zhurnal opytnoi agronomii Yugo-Vostoka	Journal of Experimental Agronomy of the Southeast

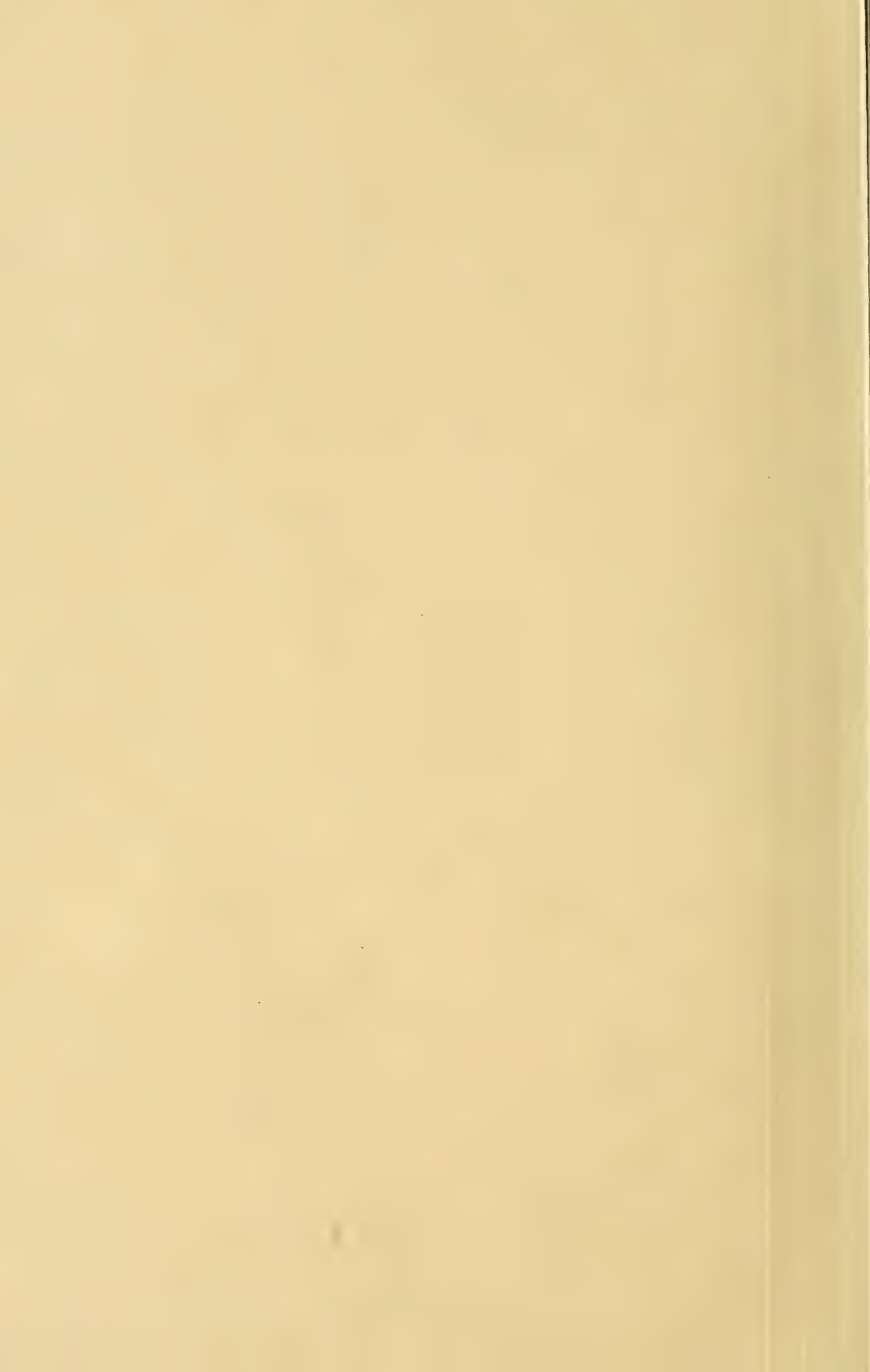


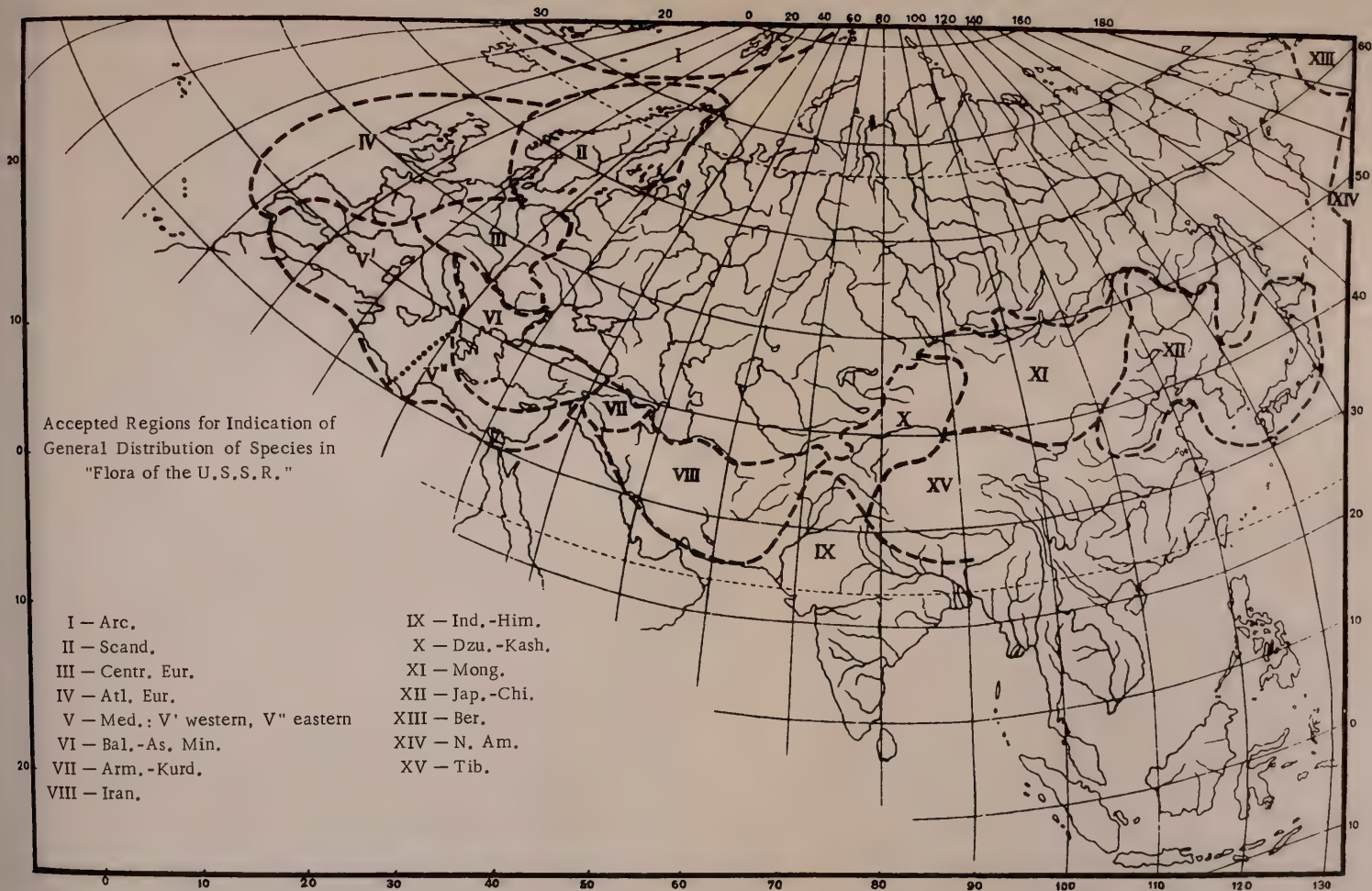
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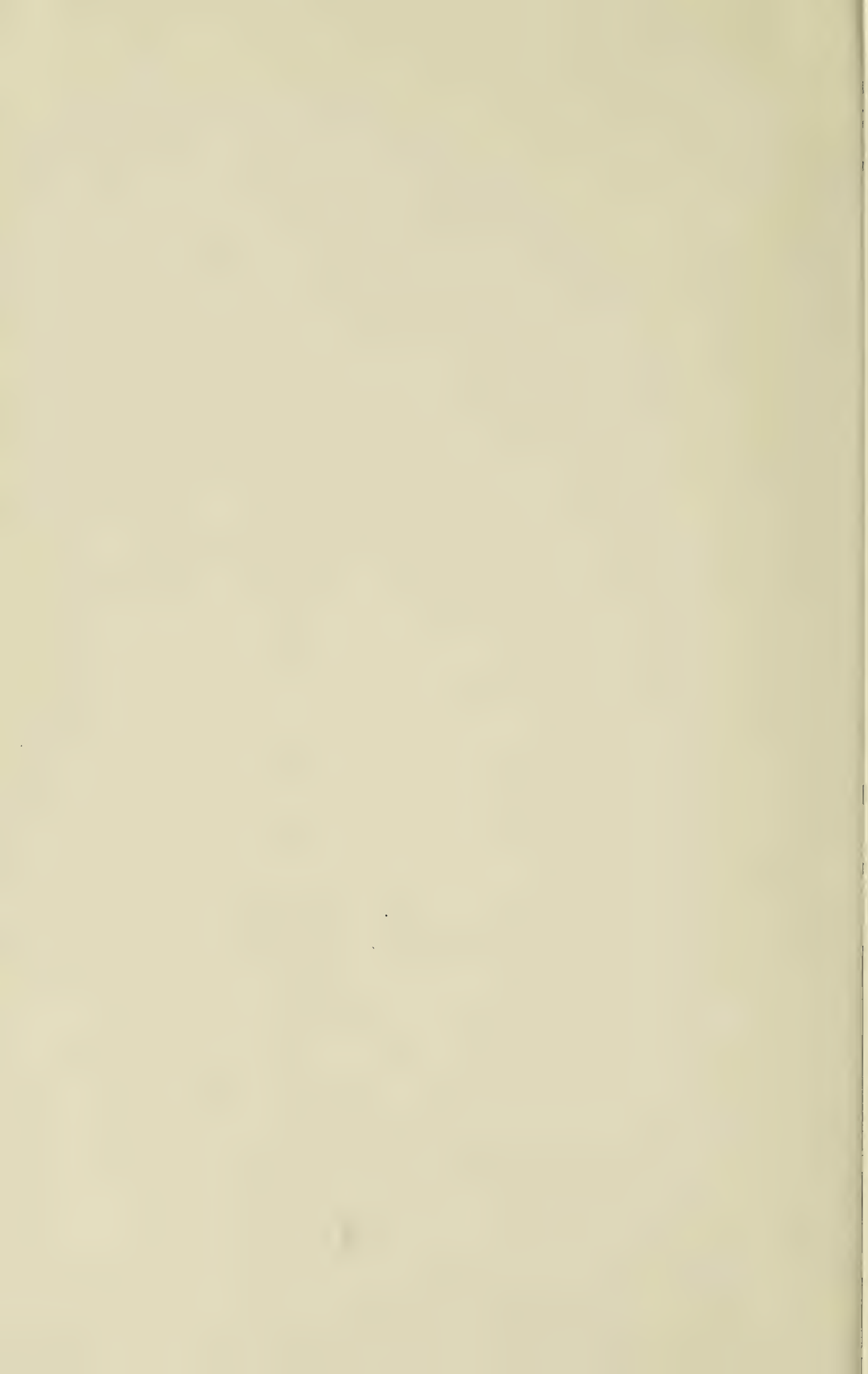








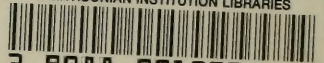








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